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GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

FUEL ECONOMY
ON
INDIAN RAILWAYS

REPORT
OF
THE RAILWAY FUEL ECONOMY ENQUIRY COMMITTEE
1953

VOLUME I

Price Rs. 2-6-0 or s. 4

CONSTITUTION AND TERMS OF REFERENCE OF THE COMMITTEE

The Railway Fuel Economy Enquiry Committee was appointed by the Government of India, Ministry of Railways, in October 1951 under the Chairmanship of Shri Darab Cursetji Driver.

Terms of Reference

"To examine the supply, consumption and reserve stocks of coal on railways and to make recommendations for economy in expenditure on coal used as fuel"

CONSTITUTION OF THE COMMITTEE

(a) 1. Shri Darab Cursetji Driver, President, Coal Consumers Association of India, Calcutta.—*Chairman.*

2. Shri R. A. Massey, Member Parliament (Now Member, Legislative Assembly, West Bengal), Calcutta.—*Member.*

3. Dr. J. W. Whiteker, Director, Fuel Research Institute. Jealgora, District Manbhum, Bihar.—*Member.*

4. Shri A. B. Guha, Chief Mining Engineer (Railway Board), (Now Member-Secretary, Coal Board), Calcutta.—*Member.*

5. Shri L. S. Corbett, Chief Mining Engineer (Railway Board), Calcutta.—*Member.*

6. Shri M. V. Kamlani, Deputy Director (Mechanical) Research, Railway Board, New Delhi.—*Member-Secretary.*

(b) **Co-opted Members.**—The Committee co-opted Shri P. L. Verma, Chief Electrical Engineer, Central Railway, for discussion and advice on matters relating to railway electrification, and Shri I. S. Malik, Deputy Coal Commissioner (Distribution), for discussion and advice on matters relating to distribution of coal.

(c) **Drafting Sub-Committee.**—The drafting Sub-Committee consisted of Dr. J. W. Whitaker, Shri M. V. Kamlani, and Shri Lal Das.

(Memorandum No. E-51CO1/11/3, dated 27th October 1951 and subsequent communications issued by the Ministry of Railways regarding the appointment and subsequent expansion of the Committee, are given in Appendix I).

ACKNOWLEDGEMENTS

We acknowledge with pleasure the courtesy, assistance, and co-operation we have received from the General Managers of the Railways, from their Departmental Heads and Deputies, from the Mining Adviser to Railways, and from the Coal Commissioner and his officers and staff. To other officers of the Railways whom we consulted and who provided us with information at various stages of our enquiries we are also indebted.

2. We wish to pay tribute to the work, energy, and tact of Shri M. V. Kamlani, Member-Secretary, whose ability and knowledge were invaluable at all stages of our deliberations.

3. We wish further to place on record our appreciation of the efficient work done by the Assistant Secretary, Shri Lal Das, whose able suggestions and assistance given in the drafting and re-drafting of the Report much lightened our task.

4. We have further to acknowledge the work done by Shri K. T. Jethmalani and the Technical Staff; they are responsible for the technical data and analyses embodied in Volume II of the Report. Finally, we have to thank Shri Jagdish Chandra and the Secretarial Staff for loyal and ungrudging service throughout.

LAYOUT OF THE REPORT

Volume I

Volume II

RAILWAY FUEL ECONOMY ENQUIRY COMMITTEE

Dated, Calcutta, 24th February, 1953

FROM SHRI D. C. DRIVER,

Chairman, Railway Fuel Economy Enquiry Committee, c/o Messrs. Macneill & Barry Ltd., 2, Fairlie Place, CALCUTTA.

To SHRI F. C. BADHWAR,

Chairman, Railway Board, Ministry of Railways, NEW DELHI.

FINAL REPORT

SIR,

I have the honour to submit the Final Report of the Railway Fuel Economy Enquiry Committee, appointed under Railway Board's letter No. E51CO1/11/3 of 27th October, 1951.

2. I would like to take this opportunity to acknowledge the valuable assistance given by individual members of the Committee and to pay tribute to their specialised knowledge and to their co-operation as a Committee.

3. I trust that the implementation of this unanimous report will prove useful in effecting fuel economy both immediately and in subsequent developments.

Yours faithfully,

DARAB CURSETJI DRIVER,

Chairman,

Railway Fuel Economy Enquiry Committee.

PART I

THE RAILWAY FUEL PROBLEM

AND

THE COMMITTEE'S RECOMMENDATIONS

CHAPTER I

THE RAILWAY FUEL PROBLEM

SCOPE OF THE PROBLEM

The annual expenditure on railway coal amounts to rupees 30·5 crores. This sum is made up of rupees 16·8 crores as the cost of coal at pithead and rupees 13·7 crores for transport and handling charges. The amount of rupees 16·8 crores may be further divided into rupees 14·0 crores for coal consumed in locomotives, rupees 1·6 crores for coal used in non-loco purposes, and rupees 1·2 crores as handling and pilferage losses. Similarly, the incidental expenditure of rupees 13·7 crores is made up of rupees 12·6 crores for operating costs for transport of coal and roughly rupees 1·1 crores for the cost of handling operations, *i.e.* unloading, stacking and reloading. **The Committee's investigations have led to the conclusion that substantial economy (approaching rupees six crores per annum) can be effected if certain measures are adopted. To understand the problem fully, however, and to achieve proper economy in the various items of expenditure, it is necessary first to consider the individual factors connected with production, preparation, supply, transport, consumption and handling of coal.** Below we give a brief statement of the main aspects of the problem. A fuller analysis will be found in the individual chapters of the report.

PRODUCTION AND TRANSPORT

2. The coal industry has developed mainly in the Bengal and Bihar coalfields, although there are substantial coal reserves in other regions. This has necessitated (and still necessitates) the transport of coal over long leads; it has resulted not only in difficulties in supply to remote regions but also in heavy strain on the rail transport of the country. And it has meant higher transport charges and consequently higher costs of coal, a basic commodity in industry.

3. Further industrial development will involve increasing demands for coal, and as the supplies are already throttled by transport inadequacy, **it is necessary not only to increase coal production on a regional basis but also to expand and develop the rail transport.** Expansion of rail transport will necessitate additional power, wagons, rail route capacities, and *also coal.* We estimate that by 1961 the country's coal requirements will have risen from the present figure of 34 million tons to as much as 52 million tons per annum. Judged in the context of coal conservation, particularly of metallurgical and high quality gas coals, the increasing requirements of coal call for urgent development measures in new coalfields and for the adoption of modern methods of coal preparation, notably size-grading and washing. It is moreover necessary to adopt a realistic and technical approach to coal grading and pricing, and to coal testing so that the coal producers may be able to guarantee the quality of their products.

Supply and Consumption

4. The annual production of coal (1951) was of the order of 33½ million tons; the demands were for 34½ million tons, whereas the transport could handle only 30½ million tons. Shortage of transport, coupled with complicated supply arrangements, has resulted in unsatisfactory supply conditions. Inspection and testing of coal loadings at colliery pitheads have been ineffective, and there has consequently been little control over quality. Furthermore, individual railway sheds have received coals from numerous and widely spread collieries and have thus been supplied with coal varying considerably in type, in quality and in physical characteristics. As a general consequence, coal issues for trip rationing of locomotives have become unreliable, and firing conditions have deteriorated. The dearth of experienced running staff, consequent on partition of the country, and stores (loco spare parts) deficiencies caused by the last war, also lowered the standards of locomotive maintenance and performance.

5. These conditions have undoubtedly led to fuel wastage. There is therefore immediate need for—

(i) ensuring regularity and uniformity of type, grade, and physical characteristics in loco coal supplies,

(ii) training the operating staff in order to raise standards of locomotive operation and maintenance,

(iii) organising shed and line working to improve engine availability in service and to minimise fuel consumption in incidental (unproductive) services, and

(iv) introducing proper trip rationing, maintaining correct accounts of fuel receipts and issues, and exercising proper control over handling, pilferage and other losses.

If action is taken on the above lines, there is no doubt that appreciable fuel saving will result, which in turn will produce proportionate saving in incidental charges. These charges can be further reduced if production and transport are organised to give short leads between the collieries and the consuming points.

Power and Fuel Research

6. Improvements in locomotive design will give further substantial economy in coal consumption. The early locomotives of BESA type had an overall thermal efficiency (to rail) of 4·4 per cent, the modernized BESA types have 5·1 per cent, the earlier IRS types 5·2 per cent. and the latest IRS locomotives 6·4 per cent. Thermal efficiency can be increased by raising boiler pressures and temperatures, by enlarging furnace proportions, by providing overall thermal insulation to reduce radiation losses, and by the application of special fuel saving devices. Railways in other countries have attained thermal efficiencies of over 9 per cent. in steam locomotives of simple expansion type, but there is a tendency for the locomotive design to become unduly complicated. From research and investigations in India, it appears possible to achieve thermal efficiencies of over 7 per cent. without jeopardising simplicity of design and reliability in performance.

7. In view of the annual expenditure on railway fuel and of the increasing traffic demands, there is clearly considerable scope for useful research on the power and fuel problems of the Railways. The need for curtailing coal requirements in favour of certain industries and for expanding rail transport to meet the increased traffic, **which is inseparable from the industrial development of the country,** warrants recourse to forms of power other than steam traction in certain regions. It is necessary continuously to examine the scope and advantages of steam, electric, diesel, and gas turbine traction with special reference to recent developments and improvements and to the requirements and needs of the country.

INVESTIGATION AND WORK OF THE COMMITTEE

8. A questionnaire was issued to Railways in November 1951 and a supplementary questionnaire was issued in 1952, (see Appendix 1). The Committee held 32 sessions (some of several days) and consulted Railways, Coal Commissioner's Organisation, Representatives of Colliery Associations, Officers of the Planning Commission Secretariat, Port Authorities etc. The Committee or its individual members paid several visits to railway headquarters, junction yards and transhipment points, running sheds, colliery base stations and coalfields, ports handling coal traffic, etc. Particulars of the visits and meetings are given in Appendix 2.

9. Preliminary investigations into supply conditions on railways revealed that the Southern Railway was suffering great hardship in the supply and cost of coal. The problems of the South were accordingly given early attention. By April 1952 the Committee submitted an Interim Report (dealing mainly with existing supply conditions and their rationalisation), which was circulated to Railways and to the Coal Commissioner for comment. Later, discussions were held with General Managers and Departmental Heads of Railway Administrations. On the suggestion of the Committee a firm of Chartered Accountants, Messrs. K. S. Aiyar and Company, Bombay was appointed to examine the coal accounts of the Western Railway, with the object of obtaining expert opinion on the existing system of maintaining railway fuel accounts and suggesting improvements. Their report was found useful in making our recommendations in Chapter XIII on Fuel Accounts and Statistics.

PLAN OF THE REPORT

10. Railway fuel problems cannot be considered as a detached issue. The consumption of coal on railways absorbs nearly one-third of the country's total production, and has a powerful influence on the conditions of production, supply, and transport of coal. Accordingly, the Committee has suggested short-term and long-term measures to improve the existing conditions and to meet future requirements adequately. These recommendations concern (1) production, (2) supply and transport, and (3) utilisation, and follow this order in the report.

11. The report is submitted in two volumes. Volume I is the body of the report and contains the main recommendations of the Committee. Volume II comprises the relevant data in the form of appendices to the various chapters of Volume I. The body of the report, Volume I, is divided into four parts. Part I discusses the scope of the railway fuel problem and contains a summary of the Committee's recommendations. Part II deals with the country's coal resources, the existing and future production and demands of coal, the need for regional development of coal production; it also contains a section on the grading, pricing and preparation of coal. Part III covers the various aspects of the problems of supply and transport. Part IV examines measures to exercise control over consumption and losses of railway coal and discusses the need and advantages of developing different types of traction. In this part also the system of maintaining and preparing fuel accounts and statistics is examined, and the setting up of fuel control organisations and training centres is considered and commended.

CHAPTER II

SUMMARY OF RECOMMENDATIONS

PRODUCTION OF COAL (REF. CH. III)

12. The Committee has briefly surveyed the position regarding reserves, production, and demands of coal in the country during the next ten years. It is estimated that the country's demand for coal will rise from about 34 million tons in 1951 to 52 million tons in 1961. The Committee considers that the production of coal in the country must now be developed in a planned manner so that each of the ten zones, into which the country has been divided for the purpose of coal supplies (*see* map at page 23) becomes self-sufficient as far as practicable. It has recommended that—

(i) Immediate steps should be taken to develop the outlying fields, particularly in Vindhya Pradesh, Madhya Pradesh and Hyderabad State, in order to meet as far as practicable the requirements of Western and Southern India and a part of Rajasthan. Northern India and the rest of Rajasthan may draw upon the coalfields of Bengal and Bihar,

(ii) The lignite resources in South Arcot, Madras, should be developed without delay,

(iii) Coal production in the Assam and Orissa States should be such as will meet the requirements of these states; special qualities of coal, however, may be obtained from outside sources,

(iv) Production of high grade non-caking coals should be increased in the Raniganj and Karanpura coalfields in order to release caking coals for (a) Metallurgical purposes and (b) feeding the export market,

(v) Government collieries at Kurasia, Deulbera and Talcher should be developed and extended by acquiring new areas without delay, wherever possible, and

(vi) Properties should be immediately acquired and Government Mines opened up in the Karanpura and Korba Coalfields.

GRADING AND PRICING OF COAL (REF. CH. IV)

13. The Committee has stressed the need for regular and frequent regrading of coal seams, and for continuous testing at **pitheads** of the quality of coal loaded. Moreover, the existing system of grading and pricing of coal is unsatisfactory and needs revision. On this issue the Committee has suggested a new approach. It is also

necessary to grade the coals of the outlying fields, hitherto ungraded. The Committee has, accordingly, recommended that—

(i) **An Official Committee under the Coal Board should be appointed immediately to examine in detail new proposals for coal grading and pricing. The Fuel Research Institute and the Ministry of Railways should be represented in this Committee,**

(ii) **Prompt steps should be taken to grade the coals of the outlying fields, and**

(iii) **Arrangements should be made to ensure continuous testing at pitheads (by Collieries) of the quality of coal loaded.**

PREPARATION OF COAL (REF. CH. V)

14. In view of the urgent need for (a) conserving the country's resources of high grade coals, (b) economy in fuel consumption, (c) economy in transport, and (d) consistency in supplies, the Committee considers it essential to adopt coal preparation measures, such as washing and sizing of coal. The advantages of these measures and the difficulties in their adoption have been discussed in detail. The Committee has recommended that—

(i) **Different types of Pilot Washing Plant should be installed at the Fuel Research Institute without delay to obtain evidence on the most suitable and economical types for coals of different washability characteristics,**

(ii) **Government should take steps to explore the possibilities of coal washing and to set up Washing Plants at selected sites.**

LIGNITE OR BROWN COAL (REF. CH. VI)

15. The Committee attaches importance to the development of lignite in the South Arcot District, Madras. This development will give relief to the South of India, which is at present suffering seriously in the matter of supply and cost of coal. The Committee's recommendations are that—

(i) **High priority should be given by Government to the mining and exploitation of the South Arcot lignite and to the establishment of thermal generating plant and industries in the vicinity of mines,**

(ii) **Steps should be taken to draw upon the experience and knowledge of Brown Coal mining in Germany, where the problems of water infiltration and handling have been solved,**

(iii) **Selected Mining Engineers from India should be sent to gain experience of the methods employed in working the Brown Coals of Germany and Australia. and**

(iv) Research should be undertaken into (a) the best method of using the lignite in locomotives (including Gas Turbine type) and in industrial plants, and (b) problems of Briquetting, Gasification, Carbonisation and Hydrogenation.

LOCO COAL REQUIREMENTS (REF. CH. VII)

16. The existing method of estimating loco coal requirements on the basis of "services on which locomotives are employed" is unsatisfactory. A rational method, based on the research carried out by the Central Standards Office for Railways, has been suggested. The Committee recommends that—

(i) Loco Coal requirements should be estimated on the basis of the suitability of each grade of caking or non-caking coal for different categories of locomotives, adjustments being made for accepting inferior coals from nearer sources,

(ii) Efforts should be made to exclude from the future Loco Coal programmes, as far as transport permits, coals whose calorific value is below 11500 BTU/LB, and

(iii) The use of low grade coals (calorific value below 11500 BTU/LB) on shunting locomotives should be gradually discontinued; districts or zones which receive supplies of coal over long leads should receive prior attention.

EXISTING SUPPLY CONDITIONS (REF. CH. VIII)

17. Under the existing arrangements individual sheds receive coal from numerous sources, resulting in irregular supplies and lack of consistency in grade and physical characteristics of coal used. Consequently, it is not possible to exercise proper control over consumption of coal in locomotives. The Committee has accordingly recommended that immediate action be taken to re-organise loco coal supplies so that the following conditions are satisfied:—

(i) Quality.—Efficient control is exercised on the quality of coal so that supplies made to railways are in accordance with specifications.

(ii) Supply and Grouping.—Districts or zones of a Railway receive coals from fixed sources, a source being either a group of collieries or a single colliery. The collieries selected to form a group should be on the same 'Pilot'. They should be chosen so that the mixing of their coals may be done without causing combustion trouble. The quantities drawn from each group towards Railway supplies should be guaranteed in advance.

(iii) Distribution and Grouping.—As far as practicable, coal for any consuming point on a Railway should be obtained from the nearest group source. The group and the connected base station are such as will permit the movement of coal to districts or zones without entailing much marshalling at base stations (and enroute) and without involving cross movements.

FUTURE LOCO COAL SUPPLIES (REF. CH. IX)

18. The Committee is of the view that, even if the existing inspection organisation with the Coal Commissioner is strengthened, it will not be possible to ensure quality in loco coal supplies. The responsibility in respect of quality should be fixed on the collieries themselves, and railway supplies should be obtained under suitable contract conditions. It is essential to set up machinery for scrutinising the offers made by collieries and for allocating supplies to railways, due regard being given to their individual requirements and to the transport available over different routes. It has accordingly been recommended that—

(i) The Railways should in future select their own coals by inviting offers from collieries and by arranging for supplies on contract basis,

(ii) A standing Loco Coal Committee should be set up to undertake all work connected with the framing of Loco Coal programmes, inviting offers from collieries, for scrutiny and acceptance, allocation of their approved offers according to the supplies and transport available. The Committee should consist of representatives of Railways, the Ministry of Railways and the Coal Commissioner. The Chairman of the Railway Board or his nominee may act as Chairman and the Chief Mining Engineer, Railway Board as member-Secretary of the standing Loco Coal Committee, and

(iii) In order to simplify and rationalise transport and to ensure regular and reliable supplies of coal to Railways, steps should be taken to introduce the system of grouping collieries, with distributing centres to serve as primary receiving points in respect of supplies to Railway zones. A sample distribution plan is given in Appendix 13.

SUPPLY OF COAL TO THE SOUTH (REF. CH. X)

19. The Committee has given attention to the coal problem of the Southern Railway in the matter of supply and cost of coal. To relieve fuel shortage in the South a five year plan has been evolved indicating the necessary development of the outlying fields and rail transport. The first phase of the plan involves the extension of transhipment facilities or of dumps, and the provision of additional 250 broad gauge and 60 metre gauge wagons, along with necessary locomotive power, and rail route facilities for carrying increased quantities of both loco and public coal. A net reduction of about rupees 26 lakhs per annum in the cost of loco coal is expected on the completion of the first phase of the plan. On the completion of the plan in five years, the net saving in the cost of loco coal is estimated to be of the order of about 33 lakhs annually. As an immediate measure attention should be given to the full loading of the wagons (including the two ton over-load allowance) especially when dealing with the Singareni coal and coal supplies to the South, where it would appear that there is the greatest need of this measure and

where the maximum advantage will accrue—and immediately. The Committee has recommended that—

(i) Wagons should be loaded to maximum permissible degree;

(ii) To meet the fuel requirements of the South, the Government should give priority to the development of Talcher, Singareni and CP/CIC coalfields; and

(iii) The Ministry of Railways should immediately undertake the development of the junction yards and line capacities along the rail routes from the above-mentioned outlying fields to the South.

TRANSPORT DEFICIENCIES (REF. CH. XI)

20. The transport available for coal is at present short of both demands and production of coal in the country. The position is worsened by geographically unbalanced production of coal, necessitating the movement of coal over long leads. The demands are expected to increase progressively by 50 per cent. in the course of the next ten years. It is, therefore, essential to expand rail transport accordingly. The Committee has evolved short-term and long-term plans for this purpose and has also suggested the revision of the existing system of allocating and allotting coal supplies and wagons. With a view to ensure efficient utilisation of the available transport and its expansion it has recommended that—

(i) A "Standing Coal Transport Planning Committee" should be set up, consisting of the representatives of the Ministries of Railways and Production and of the Planning Commission to undertake necessary planning in respect of coal transport, and to ensure that due importance is given to coal (and other goods) transport in the economic development of the country.

(ii) Wagon turn-round and carrying capacity should be improved by—

(a) Allocating coal orders colliery-wise and pilot-wise in order to form block loads. The colliery and consuming areas should be in zones and rationally linked up to afford movement of block loads along specified directions.

(b) Ensuring that wagons are fully loaded to the carrying capacity and that full use is made of the two tons overload allowance. For the purpose the Measuring Gauge, shown in Appendix 20 or a similar device should be adopted.

(c) Removing transport "Bottlenecks" and improving line capacities as recommended in the short-term and long term plans.

(iii) The existing practice of allocating coal orders and wagons should be modified to give effect to regional distribution

of coal, as far as possible, and to incorporate the following features—

(a) Allocation of coal orders on the basis of wagon availability.

(b) Linking of supplies with specified supply sources and colliery base stations.

(c) Advance programming of public supplies on a quarterly or half yearly basis.

(d) Provision of a "cushion" of 200 wagons daily for the Bengal and Bihar coalfields and 50 wagons daily for other coalfields to meet emergent demands, the allotment of this number being left to the discretion of the Coal Commissioner.

(iv) A railway officer of senior administrative rank (director) should be immediately appointed and housed in the office of the Coal Commissioner. He should function as Liaison Transport Officer and make day to day allotment of wagons in collaboration with the Coal Commissioner.

CONTROL OVER CONSUMPTION AND LOSSES OF RAILWAY COAL (REF. CH. XII)

21. Of the total railway coal supplies of about 10·5 million tons. 83·5 per cent. is consumed in locomotives, 9·5 per cent. is used in non-loco purposes, and the balance of 7 per cent. is lost in handling and pilferage. An analysis of all the direct and indirect factors affecting (a) the consumption of coal in loco and non-loco purposes, (b) the losses of coal by pilferage and in handling, and (c) the expenditure incurred in handling coal, indicates that fuel consumption (including losses) can be reduced by about 20 per cent. of the total railway supplies by the adoption of the proper economy measures dealt with in the report. These measures can be progressively enforced only through adequately staffed and independent fuel control organisations. A saving of about rupees 6 crores annually will result in the course of the next five years, on the basis of the present railway fuel bill. Additional economy can be achieved through improvement in steam locomotive design and application of fuel saving devices. These features constitute a continuous and long-term process and the extent of resultant economies will depend largely upon experimental investigations and research. The Committee has recommended that—

(i) More attention should be given to provide proper stacking facilities and stacking ground and to the adequate stacking of all supplies as a check on consumption and pilferage, and

(ii) Immediate steps should be taken to set up machinery for giving effect to the proposed economy measures, which can be broadly divided into—

(a) Control over consumption, and

(b) Power and fuel research.

The control measures should be the function of the fuel control organisations, and power and fuel research should be the concern of the Railway Testing and Research Centre, working in collaboration with the Fuel Research Institute.

FUEL ACCOUNTS AND STATISTICS (REF. CH. XIII)

22. At present the fuel accounts maintained by different railways do not properly and adequately account for coal purchases, stocks, and issues; nor is it possible from the fuel consumption and train operation statistics, as now prepared, to locate and define the causes of unusual fluctuations in coal consumption or in operational efficiency. The Committee has pointed out certain defects and indicated the line of reform in the existing system of maintaining and preparing fuel accounts and statistics. At the Committee's instance, a firm of Chartered Accountants was appointed by the Railway Board to examine the fuel accounts of the Western Railway. The Committee has briefly commented on the report, submitted by the Chartered Accountants, and has recommended that early steps should be taken to—

(i) Examine the report of the Chartered Accountants in the light of the Committee's remarks with a view to evolving a simple and effective system of fuel accounts for adoption on all the Indian Railways, and

(ii) Enlarge the scope of railway fuel statistics so that the effects of various direct and indirect factors affecting coal consumption are adequately brought out by the statistical figures.

DIFFERENT TYPES OF TRACTION AND POWER AND FUEL RESEARCH (REF. CH. XIV)

23. The need for ensuring economic utilisation of the country's assets in fuel and power, and for providing such types of locomotives as will meet the growing intensity of traffic, has prompted the Committee to make a study of the scope of different types of traction in India. The characteristics and relative economics of steam, electric, diesel, and gas turbine traction have been examined. The Committee has also shown the need for power and fuel research. It has recommended that—

(i) Electrification of the under-mentioned sections should be given consideration—

Railway	*Section to be Electrified*	*Route Miles*
Eastern	Suburban Services—	
	(i) Howrah Division	151
	(ii) Sealdah Division	138
	Main Line—	
	(i) Burdwan-Gaya	242
	(ii) Gaya-Moghalsarai	125
Central	Igatpuri-Bhusaval	192
	(Extension of the present Electrified Section Bombay-Igatpuri)	

Railway	*Section to be Electrified*	*Route Miles*
Southern	Quilon-Ernakulam	96
	Madras-Trichinopoly	358
	Madras-Bangalore	222
	Madras-Bezwada	268
Western	Virar-Ahmedabad	271
	(Extension of the present Electrified Section—Bombay Central-Virar).	
Northern	Delhi-Ambala	123
		2187

(ii) Steps should be taken to introduce—

(a) Diesel traction on the Saurashtra section (Gondal Division) of the Western Railway,

(b) Diesel light railcar services on suitable sections, and

(c) Diesel power for shunting services.

(iii) Power and fuel research should be enlarged and intensified to—

(a) establish the reliability, in operation and maintenance, of design improvements in order to expedite their incorporation in future steam locomotives,

(b) develop other types of locomotive power to meet the growing traffic requirements of the country most efficiently,

(c) develop designs of gas producers, using coal or coke, for ratings upto 400/500 H. P. in order to give impetus to dieselisation of railcar and shunting services,

(d) investigate the possibilities of using lignite in steam locomotives and in gas turbines,

(e) develop designs of combustor and heat exchanger suitable for Indian coals, to facilitate the adoption of external combustion gas turbine locomotives, and

(f) determine the performance and advantages of the high tension 50 cycle A. C. system for electric traction.

(iv) Early action should be taken to set up a "Standing Railway Power and Electrification Planning Committee", consisting of representatives of the Ministry of Railways, the Planning Commission, and the Central Water and Power Commission, for

(a) **Ensuring coordination among the authorities responsible for industrial, power, transport, fuel and other national developments,**

(b) **Initiating, scrutinizing, and recommending the execution of railway electrification and dieselisation schemes in a specified order of priority, and**

(c) **Examining the possibilities of indigenous manufacture of machinery and components to meet the maintenance requirements of electric, diesel and other types of traction.**

FUEL CONTROL ORGANISATIONS AND TRAINING CENTRES (REF. CH. XV)

24. As already indicated, there is scope for substantial reduction in consumption and losses of coal on railways. The Committee is, however, convinced that an effective and continuous economy campaign cannot be organised without adequately staffed and independent fuel control departments and without proper training of staff. There is an urgent need for developing central and regional fuel control organisations and training centres. The Committee has recommended the immediate setting up of:—

(a) **Six regional fuel control departments,**

(b) **A central fuel directorate,**

(c) **Six regional training schools, and**

(d) **A central training school.**

The set up of the regional and central fuel control organisations are discussed in paras. 422 and 430. The annual expenditure on this account is estimated to be rupees 29 lakhs against the expected annual saving of rupees 6 crores.

PART II

COAL RESOURCES OF THE COUNTRY

CHAPTER III—COAL RESERVES, PRODUCTION AND DEMAND

CHAPTER IV—GRADING AND PRICING OF COAL

CHAPTER V—PREPARATION OF COAL

CHAPTER VI—LIGNITE OR BROWN COAL

CHAPTER III

COAL RESERVES, PRODUCTION AND DEMAND

REGIONAL COAL RESERVES

25. The map at page 17 shows the regional reserves and production of coal in the country. The known reserves* are of the order of 44,000 million tons, about half of which (24,500 million tons) are located in the Bengal and Bihar States, one quarter (11,000 million tons) in the Indian Peninsula embracing Vindhya Pradesh and Madhya Pradesh, and the balance (20 per cent. or 8,500 million tons) in the remaining outlying fields. The location of the coal reserves in different regions is as follows.

Lignite or Brown Coal

26. Lignite of good quality is found in Bikaner and in Madras State. The reserves of the Bikaner lignite are estimated at about 10 million tons. The reserves of the South Arcot lignite, Madras, are estimated at over 2,000 million tons. The calorific value, air-dried, ranges from 9,000 to 10,000 Btu per lb. Lignite is discussed more fully in Chapter VI of this report.

Bituminous Coals

27. The coals of the Bengal and Bihar and outlying fields are of the bituminous quality, falling under caking and non-caking categories. The caking coals are largely produced in the Jharia, Giridih and Bokaro coalfields, although certain large deposits also occur in the Raniganj field (Western Side). Such coals are comparatively low in moisture and volatile matter. The estimated reserves of good quality caking coals. suitable for manufacture of metallurgical coke, are of the order of **1,300 million tons.** Those of lower quality (but still caking coal) are approximately 1,500 million tons (total 2,800 million tons). If washing, blending, and compulsory stowing are adopted, the amount of good quality caking (*i.e.* coking) coals can be taken as **2,000 million tons.** Total available coking coal thus amounts to about 5 per cent. of the known total reserves in the country, and about 10 per cent. of the workable coal.

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*The reserves are estimated by the Geological Survey of India for a working depth of 1,000 feet except in the case of Raniganj and Jharia coalfields where reserves up to a working depth of 2,000 feet have been taken. Seams of thickness less than 4 feet have not been included in these estimates.

With present day production methods the extractable quantities of coal may be taken as roughly 50 per cent of the total coal reserves. Adequate stowing and good mining practice can, however, raise the extractable reserves to about 70 to 90 per cent of the total estimated reserves, depending upon natural conditions.

28. The coals of Assam are of a bituminous variety, but are unusually high in volatile matter (40 to 50 per cent.) and contain 2 to 6 per cent. of sulphur, mainly organic. The ash is low, 2 to 6 per cent. and the moisture is of the order of 1 or 2 per cent. The calorific value of the coal as mined is about *14,000 Btu/lb. The estimaterd reserves are of the order of 2,000 million tons but may be far more. The coal reserves in the Garo Hills etc. are not known definitely. The Assam coals are generally of a caking type but they do not give a strong coke suitable for blast furnace work, even neglecting the high sulphur.

29. The data collected by Geological Survey in 1950 places non-caking and semi-caking (Bituminous quality) coal reserves at about 39,000 million tons. They are located as follows:—

Bengal and Bihar Coalfields. (mainly Raniganj and Karanpura).		21,743 million tons.
Outlying Coalfields.		
Orissa	240 million tons	17,371 million tons.
Central India	5629 million tons.	
Pench Valley	103 million tons.	
Chanda Valley	5357 million tons.	
Godavari Valley (including Hyderabad State)	4042 million tons.	
Assam Coalfields	2000 million tons	
		39,114 million tons.

30. The non-caking and semi-caking coals of the Bengal and Bihar coalfields (Raniganj, Jharia, Bokaro and Karanpura) are of good quality with ash generally below 20 per cent. but those of the outlying fields range from superior quality, with ash as low as 10 per cent. to inferior quality with ash exceeding 30 per cent. Much of the coal in the outlying fields, however, appears to be of inferior quality.

REGIONAL PRODUCTION

31. The total annual production of coal was about 28 million tons in 1939. It dropped to about 25¼ million tons in 1944 but rose to 33½ million tons in 1951. Table 1 gives for 1951 the region-wise annual production of caking and non-caking coals in each of the zones shown in the map.

*14,500 Btu/lb. on a pure or unit coal basis.

TABLE 1

ZONAL ANNUAL PRODUCTION OF CAKING/NON-CAKING COALS IN 1951

Zone No.	States comprising a zone	Production of coal million tons/annum		
		Caking	Non-caking or Semi-caking	Total
1	Madras, Mysore, Travancore Cochin and Coorg.	...	...	...
2	Hyderabad	...	1.2	1.2
3	Bombay, Saurashtra and Cutch . .	...	...	...
4	Madhya Pradesh, Vindhya Pradesh and Bhopal.	...	3·8	3·8
5	Madhya Bharat, Rajasthan and Ajmer . .	...	0·04	*0·04
6	East Punjab, Pepsu, Delhi, Kashmir and Himachal Pradesh	...	...	...
7	Uttar Pradesh	...	...	...
8	Bengal and Bihar	12·6	14·8	27·4
9	Orissa	...	0·5	0·5
10	Assam, Manipur and Tripura . . .	...	0·5	0·5
		12·6	20·84	33·44

*Lignite.

32. The existing region-wise production in the country is unbalanced. For instance, the coalfields in Bengal and Bihar (zone 8 in the map) produce about 27½ million tons, which is 82 per cent of the total output. The coalfields of Vindhya Pradesh and Madhya Pradesh (zone 4 in the map) produce 3·8 million tons or about 11 per cent. of the total output. The remaining coalfields in Hyderabad, Assam, Orissa and other States (zones 2, 5, 9 and 10) produce 2·2 million tons, or about 7 per cent. of the total output. Reserves of lignite in zone 1 are not yet exploited. **The remaining zones (Nos. 3, 6 and 7) have no coal reserves.**

PRESENT AND FUTURE DEMANDS

33. The actual supplies made to different consumers in 1951 against aggregate demands of 34½ million tons and annual production of 33½ million tons, have not exceeded 31 million tons per annum including about 2 million tons consumed by the collieries. Supplies have fallen behind production and demands because of transport shortage caused by—

(a) unbalanced production, requiring transport of coal over long leads and thus involving uneconomic utilisation of the available transport, and

(b) actual shortage of wagons, bottlenecks over rail routes, and unsatisfactory locomotive power.

The transport problem is dealt with in Chapter XI.

34. Table 2 below gives our forecast of the requirements of principal consumers of coal in India in the year 1961; the approximate quantities supplied to them in 1951 are also shown for comparison.

TABLE 2

ANTICIPATED DEMANDS (1961) COMPARED WITH PRESENT SUPPLIES (1951)

	Present Supplies 1951 (Million tons)	Anticipated Demands 1961 (Million tons)
Railways	10·5	13·0
Mills, factories and Engineering Works	3·0	5·5
Electricity generation	2·5	4·5
Cement works	0·5	5·0
Brick burning	1·0	
Iron and Steel	4·0	8·0
Chemical and Gas Works	0·5	2·0
Glass Works, Potteries and Refractories	1·0	2·0
Bunker and Export	3·0	5·0
Domestic requirements	2·5	5·0
TOTAL	28·5	50·0
Collieries	2·0	2·0
	30·5	52·0

It will be seen that both production and transport have to be developed for the supply and distribution of about 50 per cent. more coal in the course of the next 10 years. The basis of these estimated future requirements is discussed below.

RAILWAYS

35. With the increase in the demands of coal for industrial and domestic purposes additional transport will be required to move more coal and goods. Making allowance for increased use of road and river transport, the demands on rail transport may be expected to increase by 2 per cent per annum or roughly 20 per cent. over a period of ten years. Railway electrification is not likely to extend over a route mileage of more than 5 per cent. and steam traction will continue to predominate for a fairly long time. **Consumption of coal on railways may therefore be expected to go up to 13 million tons a year, i.e., 20 per cent. more than the present consumption. This is a conservative estimate.**

Mills, Factories and Engineering Works and Collieries

36. With the development of electricity grids, more factories, mills and engineering works will come under electrification. But new mills and factories are also expected to be established and therefore no reduction is expected in the demands of coal for mills, factories or engineering works in spite of a greater measure of electrification. The same applies to collieries. The consumption of coal for heating and processing in mills and factories is, however, expected to increase by about 2·5 million tons.

Generation of Electricity

37. The present consumption of about 2·5 million tons of coal by public utility power stations, represents nearly 1,100 Mega-Watts of installed capacity of coal-burning thermal plants in the country. With the power projects, both hydro and thermal, now being developed the total installed capacity by 1960 is expected to reach 4,000 Mega-Watts, of which approximately 1950 Mega-Watts (about 49 per cent.) should be thermal. A part of this thermal capacity is intended to level up the seasonal fluctuations in the hydro-electric grid systems. The thermal power capacity should therefore increase by 80 per cent. by 1960 and coal requirements for generation of electricity may be increased accordingly.

Cement Works and Brick Burning

38. The quantity of coal now supplied is 1·5 million tons a year. The actual demands even today are for about 4½ million tons, and these demands (particularly for brick burning coal) are not being fully met due to shortage of transport. Building construction schemes connected with industrial and agricultural developments in the next ten years will force the issue and make a demand for a minimum of 5 million tons a year on this account.

Iron and Steel Works

39. The present demands of high grade caking coals are of the order of 4 million tons. With the setting up of new plants and the expansion of the existing plants in the course of the next ten years, the requirements of high grade caking (*i.e.* coking) coal may be expected to be doubled.

Chemical and Gas Works, Glass Works, Potteries and Refractories

40. Considerable developments are envisaged in the field of Chemical Engineering and Gas Supply for various purposes. An estimated annual demand of 2·0 million tons against the item in ten years will not be on the high side. Similarly the demand for coal is expected to increase to 2 million tons for Glass Works, Potteries and Refractories.

Bunker and Export

41. Supplies against Bunker and Export have now reached the level of about 3 million tons. Bunker demands, which average at 0·7 million tons, may increase to 2·0 million tons as coastal and deep sea shipping will expand and more foreign shipping is expected to touch Indian Ports during the next ten years. Both caking and non-caking coals are now exported. In the last three years the export quantities have nearly doubled. Export coals have of necessity to be of superior qualities, and as long as high grade caking coals are produced in excess of the indigenous metallurgical requirements of the country they will probably be exported. After a few years, however, the present output of high grade caking coals will all be required for production of metallurgical coke for India, and export market may then have to deal mainly with high grade non-caking coals. Accordingly, the demands of coal for bunker and export in the next ten years are estimated to be about 5 million tons a year.

Domestic requirements

42. The present annual supply of soft coke in the country is of the order of 2 million tons and the coal required to produce this quantity of soft coke is roughly 2·5 million tons. Calculations show that for a consumption rate of, say, 2 maunds of soft coke per family of five members per month, the annual requirements of this fuel for a total population of 340 millions would be about 60 million tons, and those of the coal for producing it about 80 million tons. A very small percentage of population in the country (mainly urban population) use soft coke for cooking and other domestic purposes. With improved living conditions for the urban population, there should be progressive increase in the demands for soft coke. To some extent these demands will be offset by gas and electricity, but we estimate that in the next ten years about 5 per cent. of the country's population will be using soft coke as domestic fuel. The demand for coal for producing soft coke may therefore be expected to reach a figure of at least 5 million tons. The use of cow dung as fuel by the rural population is robbing the country of valuable natural fertiliser. It is therefore desirable to encourage the rural population to use soft coke in place of cow dung. As a measure against wasteful deforestation, it is essential to encourage the use of soft coke in the place of wood, which is now being consumed in considerable quantities as domestic fuel by both urban and rural population. Any drive in this direction will further increase the demand for coal for producing coke, but we have not taken this into account in our estimates.

PRODUCTION PLAN

Zonal Development

43. In ten years time the demands are thus estimated to increase by 50 per cent. Unless therefore the problem is immediately tackled and adequate plans are made, the position will become chaotic. The development of production on a rational basis and the expansion of transport have to go hand in hand. The present unbalanced production of coal in the country imposes an unnecessary strain on the available transport as the coal has to be carried over long leads.

For instance, at present transport has to be found to move coal from Bengal and Bihar to the extreme South and extreme West of India. This can be largely avoided if the outlying fields are sufficiently developed.

44. The map at page 17 embodies a plan for rationalising production. It envisages the division of the country into ten zones, each zone becoming as far as practicable self-sufficient in the matter of coal supplies or drawing its requirements from its nearest neighbour. This is essential not only to effect economy in transport of coal but also to ensure supplies to industries at relatively low cost, and thus to help industrial development. For each of the ten zones shown in the map there is a small table, giving the estimated reserves, present production, target production in 1961, present demands (1951) and demands anticipated by 1961. These figures have been worked out on the basis of the available evidence and the anticipated requirements of each zone, keeping in view the likely development of each zone. Table 3 shows the various States grouped into ten zones, the present production of each zone, the target production in 1961, the anticipated demands in 1961 and the anticipated surplus or deficit in each zone in 1961.

TABLE 3

ZONAL PRODUCTION AND DEMANDS

(All figures are in million tons/annum).

Zone No.	States comprising a zone.	Present production (1951)	Target production 1961	Anticipated Demand 1961	Surplus(+) or Deficit (—)production in each zone 1961
1	Madras, Mysore, Travancore Cochin and Coorg . .	...	1·2	3·1	—1·9
2	Hyderabad	1·2	2·4	0·5	+1·9
3	Bombay, Saurashtra and Cutch	...	...	5·5	—5·5
4	Madhya Pradesh, Vindhya Pradesh and Bhopal . . .	3·8	7·4	2·8	+4·6
5	Madhya Bharat, Rajasthan and Ajmer	0·04	0·1	2·1	—2·0
6	E. Punjab, Pepsu, Delhi, Kashmir and Himachal Pradesh .	...	...	3·9	—3·9
7	Uttar Pradesh	...	...	4·9	—4·9
8	Bengal and Bihar	27·4	39·5	27·9*	+11·6
9	Orissa	0·5	0·8	0·7	+0·1
10	Assam, Manipur and Tripura	0·5	0·6	0·6	...
	TOTAL .	33·44	52·0	52·0	...

*Includes 5·0 million tons as demand for Bunker and Export.

45. A study of the map and table 3 reveal that, if production is developed according to this plan, zone No. 1 (extreme south) will produce only 1/3rd of its anticipated demands in the course of the next ten years and will have to draw the balance from the nearest zone i.e., Hyderabad State. Western India and part of Rajasthan (zones 3 and 5) will receive 80 per cent. of their coal supplies from the nearest sources in Madhya Pradesh and Vindhya Pradesh (zone 4). Northern India and the rest of Rajasthan (zones 7, 6, and 5), which have not known coal reserves, will receive most of their coal supplies from the nearest sources in Bengal and Bihar. Zones 9 and 10 will be self-sufficient. In recommending this plan the Committee has not overlooked the fact that, till such time as the scope for utilisation of local coals is widened by beneficiation measures and adoption of modern utilisation technique, the different zones will have to depend for their requirements of special qualities of coals on the zones producing such qualities, irrespective of the distances involved.

Outlying Fields

46. The development of the outlying fields constitutes a major factor in the regional development of production of coal in the country. It is, however, important that in planning this development **the States concerned should sell properties to mining undertakings so as to safeguard against (a) the creation of uneconomic production units and (b) speculative transactions which may hold up development.**

47. The Committee had addressed a questionnaire to collieries in the outlying fields in order to investigate the prospects of increasing production of coal in these fields without incurring large additional expenditure on new equipment and labour. From the replies received (Summary at Appendix 4) it appears that, if transport is made available, the annual production of the CIC, Pench and Chanda coalfields can be immediately increased from 3·6 to 5·0 million tons, requiring about 700 wagons per day for loading coal as against the present despatches of about 500 wagons per day. In the course of five years the production can be increased to 8·0 million tons, requiring about 1100 wagons per day for despatching coal from these coalfields. It is clear therefore that the production target of 7·4 million tons for 1961 envisaged in our plan in respect of the CIC, Pench Valley and Chanda Valley collieries can be achieved in five years, with moderate additions to colliery plant and equipment, and that our target figures are practicable.

48. As regards the collieries in the Hyderabad State, the production target indicated by the Singareni collieries will amount to 2 million tons per year at the end of five years and will involve an expenditure of about rupees 4 crores for power and equipment to achieve this output. The programme for the development of Singareni coalfields is given in Appendix 18 relating to the plan for supply of coal to South India. There appears to be little difficulty in developing Talcher and Assam Collieries to make the States they serve self-sufficient, but the exploitation of South Arcot lignite warrants immediate planning. The development of this project will involve heavy expenditure.

49. To conserve coking coals, the Planning Commission has programmed the replacement of such coals by increased production of non-caking coals to the extent of 3·77 tons per annum. Our plan envisages a bigger increase in the production of non-caking coals and thus provides a wider scope for conservation measures.

GOVERNMENT COLLIERIES

Production and Supply

50. A list of Government collieries showing the output of different grades of coal during the year 1951-52 is given in Table 4 (page 26). It will be seen that the Government collieries produce at present about 3·2 million tons of coal per year, forming nearly 1/10 of the total coal production in the country. About 80 per cent. of the output is used as steam coal, most of which is supplied to Railways. The balance of 20 per cent. is slack, some of which is supplied to Railways and some to other Government departments and industries. The Railways thus receive in all about 85 per cent of the Government collieries' output which forms nearly 1/4th of their total coal requirements. Overall supplies of coal from the Government collieries is a stabilising factor, as emergencies arising from the failure of supplies from Market collieries can be speedily met by despatch of additional coal loads from these collieries.

Conservation Policy

51. The supplies to railways of different grades of coal from the Government collieries and the Market collieries are roughly as shown in table 5 below.

Table 5

GRADEWISE RAILWAY COAL SUPPLIES FROM MARKET AND GOVERNMENT COLLIERIES 1951

Grade of Coal	Supplies from				Total	
	Government Collieries		Market Collieries		Quantity in million tons	Percentage of total
	Quantity in million tons	Percentage of total	Quantity in million of tons	Percentage total		
Selected Grades .	0·26	7%	3·44	93%	3·7	100%
Grade I . .	2·10	50%	2·10	50%	4·2	100%
Grade II . .	0·26	10%	2·34	90%	2·6	100%
All Grades .	2·62	25%	7·88	75%	10·5	100%

About 80 per cent of the coal of selected grades and of grade I qualities supplied to railways from the Government Collieries is caking coal. The Committee on the Conservation of Metallurgical

TABLE 4

TABLE SHOWING THE LIST AND GRADE-WISE OUTPUT OF GOVERNMENT COLLIERIES FOR THE YEAR 1951-52

(In thousands of Tons)

Name of Colliery or quarry		Output during 1951-52						Total		
		Sel. A	Sel B.	Gr. I	Gr. II	Gr. III A	Gr. IIIB	Caking	Non-Caking	Grand Total
1. Kargali	(C)	...	...	612.0	...	...	...	612.0		
2. Bokaro	(C)	...	...	1373.6	62.6	...	...	1436.2		
3. Jarangdih	(C)	...	...	...	23.4	...	...	23.4		2424.3
4. Swang	(C)	...	...	43.8	...	...	...	43.8		
5. Kurharbaree	(C)	142.5	...	...	...	...	...	142.5		
6. Serampore	(C)	86.7	58.1	...	...	16.8	4.8	166.4		
7. Argada	(NC)	...	...	100.8	...	...	...	...	100.8	
8. Bhurkunda	(NC)	...	...	180.6	...	...	...	...	180.6	
9. Talcher	(NC)	...	...	...	134.0	...	...	...	134.0	731.5
10. Deulbera	(NC)	...	...	...	87.0	...	...	...	87.0	
11. Kurasia	(NC)	...	...	229.1	...	...	...	...	229.1	
		229.2	58.1	2539.9	307.0	16.8	4.8	2424.3	731.5	3155.8

NOTE.—'C' denotes Caking.
'NC' denotes Non-Caking or Semi-Caking.

coal has already recommended that the production of such caking coal in the country sould be restricted to the quantities required only for metallurgical purposes. This restriction on the production of caking coal will naturally affect the output of the Government Collieries **unless new areas containing high grade non-caking coals (preferably in the outlying fields) are acquired and developed,** and unless steps are also taken to increase the output of the existing Government Collieries producing non-caking coals. The reduced production of caking coals has therefore to be made good by increased production of non-caking or semi-caking coals from—

(a) Raniganj and Karanpura coalfields in Bengal and Bihar, and

(b) Outlying fields.

52. The production of caking coals in the Kargali and Bokaro collieries has now been restricted by the Coal Board. **Accordingly, it is necessary at once to acquire and develop new areas in the fields containing non-caking coals of grade I and higher qualities.**

53. The Coal Commissioner has informed us that the annual production, during the coming five years, from the Deulbera and Talcher collieries can be increased from 87,000 (0·87 lakh) tons and 134,000 (1·34 lakhs) tons to 100,000 (1 lakh) and 180,000 (1·8 lakhs) tons, respectively, provided that certain areas/quarries adjacent to the existing lease-holds of Talcher and Deulbera are obtained from the Orissa Government immediately. Further, the present annual output of the Kurasia Collieries can be raised from 229,000 (2·29 lakhs) tons to 360,000 (3·6 lakhs) tons by strip mining methods. **The increase in production of the Kurasia, Deulbera and Talcher Coalfields and the development of the new mines in the Koraba coalfields (which the Central Government should acquire) will enable the railways to plan their supply arrangements for the Southern, Western and Central Railways, on a rational basis.**

54. Coal samples drawn from the Korba areas have shown that this coal is a free-burning non-caking coal often of a quality between grade I and Selected B, and suitable for locomotives and large capacity thermal stations such as **Chola Power House.** We consider that the Central Government should acquire without delay, from the Madhya Pradesh Government, property in the Korba coalfields (not yet fully prospected) and develop it for supply of coal to railways in this area. Restriction on the output of caking coal from Bokaro and Kargali collieries necessitates the immediate opening of the Korba property in order to assure supplies of good quality coal to Railways. **The Government Collieries with available skilled personnel and mining knowledge should be able to develop the Korba coalfields rapidly, especially with the help of Madhya Pradesh Government.**

55. Essential to the development of collieries in the Raniganj, Karanpura and outlying fields is the provision of adequate rail route capacity for the supply of coal to the different parts of the country. For example, increased production of the Talcher, Kurasia and Singareni fields, and the opening of new mines in the Korba area will not of themselves remove the difficulties in supplying coal to the South. There must be simultaneous expansion of the rail route

capacity *via* Waltair, Bezwada, Secunderabad and Raichur. These transport issues are dealt with in Chapter XI.

56. The main conclusion that we draw from the above survey of reserves, production, and demands of coal in the country is that **the coal production of the country must be developed in a planned and balanced manner so that each zone becomes self-sufficient as far as practicable, and that the rail transport must be developed IN ADVANCE.**

RECOMMENDATIONS

57. We recommend that—

(i) Immediate steps should be taken to develop Outlying Coalfields, particularly in Vindhya Pradesh, Madhya Pradesh and Hyderabad State, in order to meet as far as practicable the requirements of Western and Southern India and part of Rajasthan. Northern India and the rest of Rajasthan may draw upon the Coalfields of Bengal and Bihar.

(ii) The lignite resources in South Arcot, Madras, should be developed without delay,

(iii) Coal production in the Assam and Orissa States should be such as will meet the requirements of these States; special qualities of coal however may be obtained from outside sources,

(iv) Production of high grade non-caking coals should be increased in the Raniganj and Karanpura Coalfields in order to release caking coals for (a) metallurgical purposes and (b) feeding the export market,

(v) Government Collieries at Kurasia, Deulbera and Talcher should be developed and extended by acquiring new areas without delay, wherever possible, and

(vi) Properties should be immediately acquired (and prospected) and Government Mines opened up in the Karanpura and Korba Coalfields.

CHAPTER IV

GRADING AND PRICING OF COAL

Present Grading

BRIEF REVIEW

58. In 1926 the Indian Coal Grading Board introduced a scheme for grading coals for export. In 1944 the Coal Commissioner introduced a grading scheme for coals for internal use. These two schemes are reproduced below—

"A. INDIAN COAL GRADING BOARD SCHEME (1926)

(Low Volatile Coal)

(Barakar and Kurhurbaree Series)

Upto, but not exceeding 13 per cent. ash and over 7,000 calories.*	... Selected Grade
Upto, but not exceeding 15 per cent. ash and over 6,500 calories.	... Grade I (One)
Upto, but not exceeding 18 per cent. ash and over 6,000 calories.	... Grade II (Two)
Any coals inferior to the above.	... Grade III (Three)

(High Volatile Coal)

(Raniganj Series)

Upto, but not exceeding 11 per cent. ash. Over 6,800 calories. Under 6 per cent. moisture.	... Selected Grade
Upto, but not exceeding 13 per cent. ash. Over 6,300 calories. Under 9 per cent. moisture.	.. Grade I(One)
Upto, but not exceeding 16 per cent. ash. Over 6,000 calories. Under 10 per cent. moisture.	... Grade II (Two)
Any coals inferior to the above.	... Grade III (Three)"

*The word 'calories' means 'calories per gram' throughout. To convert calories per gram to Btu/lb. it is necessary to multiply by 1·8. Thus 7,000 calories per gram is equal to 12.600 Btu per lb. The above calorific values are on 'Dry Coal' basis and are gross calorific values.

The following adjustments have been made by the Board, by resolution:—

"Should a high volatile coal exceed the maximum percentage of ash plus moisture by 1 per cent. or less and by reason of this be excluded from a certain grade it shall qualify for that grade provided it carries 200 calories more than the minimum specified for that grade."

"B. COAL COMMISSIONER'S GRADING SCHEME (1944)

Coal from Seams of the Raniganj Series.

If the ash and moisture content thereof—

(i) does not exceed 17·5 per cent.	...	Selected Gr. B.
(ii) exceeds 17·5 per cent. but does not exceed 19 per cent.	...	Selected Br. B
(iii) exceeds 19 per cent. but does not exceed 24 per cent.	...	Grade I
(iv) exceeds 24 per cent. but does not exceed 28 per cent.	...	Grade II

Coal from any other Seams

If the ash content thereof—

(i) does not exceed 15 per cent.	...	Selected A
(ii) exceeds 15 per cent. but does not exceed 17 per cent.	...	Selected B
(iii) exceeds 17 per cent. but does not exceed 20 per cent.	...	Grade I
(iv) exceeds 20 per cent. but does not exceed 24 per cent.	...	Grade II
(v) exceeds 24 per cent. but does not exceed 28 per cent.	...	Grade III-A
(vi) exceeds 28 per cent. but does not exceed 35 per cent.	...	Grade III-B

Mineral having an ash content in excess of 35 per cent. shall not be vendible as coal."

59. It will be seen that in the 1926 grading scheme the Coal Grading Board took into consideration ash, moisture, and calorific value, as the three factors governing the evaluation of quality in coal.

The 1944 scheme of the Coal Commissioner, which is still in force, omitted calorific values in order to facilitate during the war period (1) the work of grading and (2) the introduction of price control.

COMMENTS ON PRESENT GRADING

60. Broadly speaking, the 1944 grading scheme has the following drawbacks—

(i) Calorific value has been given no consideration, and

(ii) the separate and different effects of moisture and of ash on the combustion are not allowed for but are considered to be of equal detriment.

Moisture in coal is variable, especially in a high moisture coal. Its quantity varies with the season (humidity and temperature) of the year and with the exposure the coal has undergone. A classification therefore depending on moisture is in any case unreliable.

61. **Calorific Value.**—Calorific value is an important factor in fuel evaluation, and the price paid for a grade of coal should be related to the potential heat (or energy) value of the coal. Under the present grading scheme of 1944, which does not specify calorific value, the actual variations in calorific value are usually as follows:—

Grade	Calorific value in Btu per lb.	
	Lower limit	Upper limit
Selected 'A'	12,200	13,300
Selected 'B'	11,800	12,600
Grade I	11,200	12,200
Grade II	10,200	11,400

The variations in any one grade (between upper and lower limits) are thus of the order of 10 per cent. and there is definite overlap between the grades.

62. Combustion in a boiler is sensitive to changes in the calorific value. Where locomotive boilers are concerned (Appendix 6), a variation of 3 to 4 per cent. in the calorific value of the "unit coal" (pure organic coal substance) is known to give a variation in coal consumption of about 6 to 8 per cent. Similarly, a variation of 7 to 8 per cent. in calorific value of "unit coal" gives a variation in coal consumption of about 15 to 20 per cent. Thus, for a given grade of coal (*i.e.*, for the same percentage of 'ash' or 'ash plus moisture') the coal consumption increases appreciably with fall in calorific value. This variation makes the check over coal consumption difficult. **Calorific value introduced into the grading scheme, will facilitate and rationalise control over consumption.**

63. **Moisture.**—Research in recent years has shown that moisture in coal, upto about 10 per cent, accelerates combustion and may improve boiler efficiency. A full explanation for this beneficial association of moisture with combustion performance has not yet been reached. Various research bodies in different countries are investigating it. Only when a better explanation is forthcoming, will it be

possible to make a more correct evaluation of the effects of moisture, as inert matter reducing the potential heat value, and as an active agent helping the process of combustion.

64. **Ash.**—Ash (derived from foreign mineral matter present in coal) on the other hand, is objectionable and interferes with the rate of combustion. Its presence in quantity prevents intimate contact between oxygen of the air and the carbon of the coal. For the same power, fuel consumption with high ash coal is far greater than the consumption with low ash coal. On an 'ash plus moisture' grading, the ill effects of ash are concealed rather than revealed. **Two coals, one of high ash and one of low, should not therefore be classified as of equal value if the difference in ash is made up by an equal difference in moisture. In short, high ash is far more objectionable than high moisture.**

RECENT STUDIES IN COAL GRADING

Scheme proposed by the Fuel Research Institute

65. The Fuel Research Institute has made a study of the characteristics of low moisture (usually low volatile) and the high moisture (usually high volatile) coals, and has put forward suggestions for a new grading scheme in the article entitled "The Price of Coal Raw and Washed", published in the November 1951 issue of 'Fuel Research Institute News'. The publication containing this article is included as Appendix 5.

66. **Advantages claimed.**—The scheme proposed by the Fuel Research Institute attempts to overcome the drawbacks of the present coal grading scheme, and is successful in so far as:—

(i) It eliminates difficulties in grading which arise from variations in the moisture content, particularly of the high moisture (high volatile) coals, by adoption of 'moisture free' (dry sample) basis for grade evaluation.

(ii) It takes into consideration calorific value of the pure coal substance (unit coal).

(iii) It introduces a Price Point Scale which **penalises** ash in coal in accordance with the influence of ash on combustion conditions.

(iv) It offers a common basis for grading all coals used for combustion whether they have high or low moisture, or high or low volatile matter of high or low calorific value.

Comments on the proposed Fuel Research Institute Scheme

67. Comments have been offered by the Member-Secretary (Mr. M. V. Kamlani) on the grading scheme of the Fuel Research Institute in the light of locomotive performances. These comments are given in Appendix 6.

68. **Price Evaluation.**—The Fuel Research Institute and the Central Standards Office for Railways agree on the basic principle of price evaluation which unlike the existing price grading scheme consists in fixing a price scale for the useful heat of each grade of coal in actual combustion. There is, however, difference of opinion about the factor or co-efficient to be used for penalising ash in determining the useful heat of each grade of coal in combustion. The factor recommended by the Fuel Research Institute is 1·5. The performance data contained in Appendix 6 show that this figure applies fairly to the behaviour of coal in stationary boilers—especially large boilers. For locomotives, however, the factor recommended by the Central Standards Office is 2·0 and this applies to locomotives of the new designs (WP and WG). The factor for locomotives of old designs is as high as 2·5.

69. The Central Standards Office investigations show the scale of consumption in locomotives (operating under given conditions) for the different grades of coal. On the basis of this scale (Appendix 6) the price structure of the present grading scheme makes the lower grades of coal (particularly grade II coals) uneconomical in locomotives. Even under the proposed Fuel Research Institute Scheme, the price of grade II coals would still make them an uneconomical proposition as railway fuel. We have indicated in paras. 147 to 152, Chapter VII, that the locomotive firebox cannot be designed of sufficient capacity to make it an efficient furnace for high ash coal, and unless the price of such coal is reduced considerably the use of low grade coals will of necessity **increase the railway fuel bill.**

70. **Prospects of coal washing.**—The prices worked out for different grade coals on the basis of the useful heat values, furnished in Table IV of Appendix 6 show that the difference between the new prices of selected A and grade II coals (in the case of stationary boiler) will be about rupees 2-14-0 per ton as against rupees 2-4-0 under the existing price structure. An increased difference in price (whatever be the price datum fixed from considerations of coal raising costs) will encourage washing of coals.

OUTLYING FIELDS

71. **Grading of coals in the outlying fields.**—The coals raised in the outlying fields are generally high moisture coals of non-caking types, ranging in grades—if determined on the basis of the existing grading scheme—from selected B to grades I, II, III-A and III-B. These coals have not yet been graded officially but they are mainly of grade I and lower qualities.

72. Railways receive over 70 per cent. of the 'steam' coal (1″ and above) produced by the outlying fields. They have often complained that the coals of the outlying fields are not consistent in quality. The probable explanation is that, **in the absence of grade specification the collieries in these fields take little interest in picking and screening and do not maintain standards in their supplies.** We consider that, to ensure quality in supplies from the outlying fields, early opportunity should be taken to grade such coals. This is all the more imperative in view of the developments that are expected to increase production from the outlying fields by several million tons within the next five to ten years.

73. We consider that the time is ripe for an overhaul of the present price grading scheme. In this we are supported by the Working Party for Coal Industry who have indicated in their report that a need exists for recasting the price grading of coals. The Committee, however, is under no delusion that a technically sound price grading scheme will by itself solve the problem of quality of supplies. Additional factors, which add to the difficulties of the problem, are (1) variability in the quality of the seam and (2) bad and careless loading at collieries. **We are strongly of the view that the need exists for regular and frequent regrading of the seams, and for CONTINUOUS TESTING at pitheads of the quality of the coal loaded.** Coal washing will of course give reasonable consistency in the washed product, independently of upgrading, but here also daily test checks at the washery are necessary.

RECOMMENDATIONS

74. We recommend that—

(i) An Official Committee under the Coal Board should be appointed immediately to examine in detail new proposals for Coal Grading and Pricing. The Fuel Research Institute and the Ministry of Railways should be represented on this Committee,

(ii) Prompt steps should be taken to grade the Coals of the outlying fields, and

(iii) Arrangements should be made to ensure continuous testing at pitheads (by collieries) of the quality of coal loaded.

CHAPTER V

PREPARATION OF COAL

General Review

75. Run-of-mine coals should be "prepared" before they are marketed to meet the needs of different consumers. Preparation of coal implies "cleaning", "sizing" and "upgrading by washing". Cleaning is a normal feature of modern production, and consists in the picking, generally by hand, of shaly matter, rock or dirt, from the pit raisings in order to bring the coal up to the grade specified for the seam worked. **There are, however, serious complaints, particularly from the Railways, that the coal supplied is not properly cleaned and contains large percentage of shale and dirt.** It is therefore essential that the producers in the country give more attention to this aspect of the matter.

76. As regards sizing and upgrading of the run-of-mine coals. these two features of coal preparation warrant serious consideration in order to meet requirements of the consumers in various "size grades" and also to facilitate—

(a) rationalisation of production of coal in the country, and

(b) conservation of higher grades of coals.

The implications of large scale adoption of sizing and upgrading (by washing) are discussed below.

SIZING

77. Sizing implies the screening of coal to meet different size grade requirements of consumers desiring efficient utilisation of coal in different plants. This preparation may also involve, if necessary, the breaking of large size coal to a certain degree. **Size grading of coals implies mechanical screening, if the quantities to be handed are large.**

78. So far, the consumers in this country, including Railways, have not insisted on closely sized coals. It has, however, been established by investigations and research carried out in various countries over long periods, that, for efficient utilisation. coals should be used within certain ranges of sizes specified for different purposes. **For instance, coal sized to the range of 2″ to 4″ will burn more efficiently** in a hand-fired locomotive boiler than will unsized steam coal of the same grade and seam. Similarly coal closely sized to the range 1″ to 2″ or ½″ to 1″ can usually be burnt more efficiently in stationary boilers, although chain grates and spreader stokers of boilers at thermal stations can usually handle the slack now supplied. The Indian Standards Institution has considered the needs of differ-

ent consumers for coal of suitable size grades and has recommended, as in table 6, (Page 37) certain ranges of size grades to cover the numerous requirements for combustion, gasification, metallurgical and other purposes. Size grading of coal on the lines indicated would, we consider, lead to increased combustion efficiency and economy. It also helps standardization of designs of grates, furnaces, hearths, mechanical stoking appliances etc. We commend the work of the Indian Standards Institution.

COAL WASHING

79. We have already indicated in Chapter III the urgent need for developing the production of coal in the country in a balanced manner so that each zone becomes largely self-sufficient and transport is minimised. Efforts in this direction, however, will have to reckon with the fact that much of the coal of the outlying fields (except Assam) is of inferior quality—with ash above 20 per cent. It will not therefore be possible to meet the zonal requirements of higher grades of coals from the outlying fields (nearer sources) unless measures are adopted to upgrade such coals. In addition to economy in transport, economy in coal consumption (particularly in locomotives) is an important and pressing factor in favour of such beneficiation. **For a given amount of steam produced the consumption of grade II coal is about 40 per cent more than that of Selected 'A' grade coal in old designs of locomotives, about 30 per cent more in the new designs of locomotives and about 20 per cent more in stationary boiler plants (see para. 147, Chapter VII).** Moreover the 1951 Committee on Conservation of Metallurgical Coal has drawn attention to the need for beneficiating lower grades of caking coal in order to increase the available reserves of coals suitable for the manufacture of metallurgical coke.

80. At present, certain quantities of grade II coals of the Bengal and Bihar coalfields are accepted towards railway and public supplies. This practice may have to continue until measures are adopted to beneficiate them. On the other hand, at present **the lower grades of coals raised in the outlying fields have all to be accepted towards railway and public supplies as a matter of economy and convenience in transport.** Clearly, one way of easing the situation is to upgrade these coals by washing. Other advantages of washing are:—

(i) The ash in the washed coals remains practically constant, which minimises inspection of coal supplies and consequently reduces inspection costs.

(ii) Washed coals are usually sized to specific requirements. These coals can therefore be prepared to give more efficient combustion.

81. Grade for grade, washed coals will be superior for combustion purposes to hand picked or mechanically prepared unwashed coals. Accordingly the economic possibilities of coal washing are not limited

TABLE 6
SIZE GRADING OF COAL AND COKE

Group	Nominal size in inches	Size ranges in inches (*square mesh) — At the point of loading: Maximum top size*	At the point of loading: Minimum top Size†	At the point of loading: Bottom size‡	At the first point of un-loading: Maximum top size*	At the first point of un-loading: Minimum top size†	At the first point of un-loading: Bottom size‡
Coal—							
Large	6 to 2	8	4½	1¾	8	4½	1½
Rubble	2 to 1	2½	1½	¾	2¼	1¼	5/8
Smithy	1 to ½	1	¾	¾	1	¾	¼
Slack (two inch)	2 to 0	Maximum per cent. under size through 1/8″ mesh				...	20
Slack (one inch)	1 to 0	Maximum per cent. under size through 1/8″ mesh				...	30
Slack (½ inch)	½ to 0	Maximum per cent. under size through 1/8″ mesh				...	60
Coke—							
Hard coke	6 to 1½	8	4½	1¼	8	4½	1
Hard coke, rubble	1½ to 1	2	1	¾	2	1	5/8
Hard coke, smithy	1 to ½	1	¾	3/8	1	¾	¼
Peas	½ to ¼	5/8	...	¼	...	...	¼
Breeze (½ inch)	½ to 0	...	...	...	...	...	...
Breeze (¼ inch)	¼ to 0	...	...	...	...	...	...
Soft coke	above 1	...	...	7/8	...	...	½

*The round hole (diameter) and the corresponding square mesh size are as follows : (sizes below ½″ are same for R. H. and square mesh).

R. H. Size	9	8	6	5	4	3½	3	2½	2¼	2	1¾	1½	1¼	½	
S. mesh size	8	7	5¼	4¼	3½	3	2⅝	2⅛	1⅞	1¾	1½	1¼	7/8	5/8	3/8

*† and ‡ Tolerance allowed in each case is as follows :—
*Not more than 5% shall be retained on maximum top size mesh.
†At least 5% shall be retained on minimum top size mesh.
‡. *For coal.*—Not more than 5% shall pass through the bottom size mesh.
For Coke.—(*a*) Not more than 2% shall pass through the bottom size mesh for hard coke and rubble.
(*b*) Not more than 5% shall pass through the bottom size mesh for smithy, peas, and soft coke.

to grade I or II and lower grades. In fact washing can often be extended with advantage to selected grade coals. **But the economic factors in coal washing have to be studied separately for each individual case.**

Coal Washing Problem

82. In the present pattern of production of coal in the country the output of a large number of collieries is low, and ranges from 500 to 5,000 tons a month. **Collieries with such low outputs should be encouraged to combine and form bigger production units of say 30,000 tons a month.** In some cases such amalgamation may prove impracticable, but in others it will prove highly beneficial, as large washeries are more economical in cost per ton of coal treated. Plans for rationalisation of production of coal in the country may therefore envisage the possibilities of—

(a) grouping of small colliery units to form bigger units,

(b) setting up of washeries receiving raw coals from neighbouring collieries, and

(c) mechanisation of coal handling and installation of washeries with screening plants.

83. Research on the washing of Indian coals has shown that they are more difficult to wash than are British and American coals. A great proportion of the ash in Indian coals is found intergrown with coal substance, and, even when the coals are broken to small size (say down to ½″), it is not possible to separate as a rule more than half the dirt from the coal substance. British 'run-of-mine' coals, on the other hand, carry much of their dirt in the form of separate lumps or layers of shale most of which can be removed satisfactorily even in fairly big sizes.

84. Nevertheless, pioneering investigations carried out under the aegis of the Fuel Research Committee at the Indian School of Mines and by the Tata Iron and Steel Works, and in more recent years at the Fuel Research Institute, Jealgora, have established that many Indian coals when broken can be washed with advantage, *i.e.*, can be upgraded in quality. Continuous investigations in this direction are conducted by the Fuel Research Institute with the object of elucidating the behaviour of different Indian coals in washing, and of devising and recommending to the collieries the best types of washing plant for individual coals in the light of the product or products desired. The Fuel Research Institute has already published several valuable studies in coal washability. It is, of course, highly desirable that washing should result in the maximum yield of the higher grade products, and the minimum losses of combustible matter (and especially of coking coal) in the rejects. In India practical experience of washing is limited to the heavy medium Chance Sand Washing Plants installed at the West Bokaro and Jamadoba collieries by the Tata Iron and Steel Company. The coal washed in these plants is of the caking variety. Further details are given in the note con-

taining Mr. A. Farquhar's evidence, appearing at Appendix 7. The washing costs are stated by Mr. A. Farquhar to be about annas 12 per ton at West Bokaro Washing Plant, which is working at an average capacity of 115 tons per hour for 16 hours per day.

85. When coals are washed for steam raising purposes, there are limitations to crushing and to repeated passing of (crushed) middlings through the washery. The sizes required for locomotive boilers are usually 2″ to 4″ or 1″ to 3″, and for stationary boilers 1″ to 2″ and ½″ to 1″ or slack ½″ to 0″. For loco coals therefore the advantage of the second pass of the middlings through the washery may be only partially realised, as the production of much small coal below ½″ will result.

86. The Committee on Conservation of Metallurgical coal outlined the financial implications of coal washing in its Report Published in 1951, and attempted an estimate of costs on the basis of average washability characteristics of Indian coals as suggested by laboratory investigations. For a heavy medium washing plant of 100 tons of raw coal per hour, the additional expenditure to be incurred by the producers in washing lower grades of coals to Selected 'A' grade was estimated to be:—

Selected 'B' to Selected 'A'	=7·5 annas per ton.
Grade I to Selected 'A'	=22 annas per ton.
Grade II to Selected 'A'	=32 annas per ton.

This additional expenditure (which is really a loss to the producer) relates to the operating costs of the washery. The further expenditure involved in the transport and handling of coal from the pitheads to the washery, by ropeways and rail lines, has still to be added to the above figures, and these costs have to be worked out for each individual case. They are likely to be heavy for a central washery receiving raw coal from a number of collieries.

87. The costs, however, involved in the washing process are offset by avoidance of hand-picking, also hand-screening and hand-loading in the case of manually worked collieries. The figures for such charges may vary from rupee 1 per ton to rupees 2 per ton. Other charges associated with colliery labour employed on the above manual operations arise from expenditure on food rations, bonuses, housing facilities, etc. Considering all costs and the net returns from the washery products the Committee on Conservation of Metallurgical Coal suggested that with favourable conditions the producer may incur little loss in washing his coal. **Capital costs, however, for coal washing plants have tended to rise in the past 2 years and, at many if not most collieries, the washing of coals may well prove uneconomical under the present price grading structure. This should be borne in mind the (recommended) regarding of coals and fixation of prices.**

88. The development of coal washing in this country has to overcome many difficulties. Some of the more obvious problems involved are (a) suitable location of plant, (b) water supply, (c) transport from colliery pit-heads to washeries, (d) quality and disposal of middlings, (e) choice of washing plant and equipment, (f) sizes of coal to be produced, and (g) disposal of rejects.

89. One of the results of washing Indian coals is that the rejects (ash of about 50 per cent.) carry a considerable quantity of combustible matter which will be inevitably lost. Such rejects can sometimes be utilised for stowing purposes (if safe from spontaneous combustion) but frequently there is expenditure involved in their disposal. Moreover, the organisation whereby a number of collieries will continuously send their coals (of different washability characteristics) to continually operating washeries, and receive payment presumably according to the grades of coal supplied to the washery, will require much thought and planning. It may be necessary for the collieries to sell direct to the washeries, the price being fixed not only by the grade of coal but also by the washing potentialities of the coal. In many cases individual collieries (or a group of collieries) may wish to have their own washery. We are not persuaded that Central Washeries are the **universal** solution of the problem. There is need for full consideration of each case. We are of the opinion that researches into the washability of Indian coals should be continued at the Fuel Research Institute, and that different types of pilot plant should be installed there in order to obtain evidence regarding the most suitable and economical types for washing various coals to particular requirements. **The Government, as one of the largest consumers and owners of collieries, should collaborate in these investigations, and consider fully the economics and other problems of washing the coals produced or used by them.**

90. To sum up, large scale adoption of washing of coals in India will increase the supplies of higher grades of coal, will ensure consistency in the supplies, and will consequently improve locomotive performance. At the same time it will reduce coal transport with consequent increase in wagon availability. But these advantages may be outweighed by heavy costs and by large loss of coal as rejects from the washery. This points to the need for thorough examination of the economics of coal washing in India by experts along with the Government Cost Accountants, who should be supplied with all relevant data from the existing washeries in India, from the Fuel Research Institute, from the Railway authorities, and from the Coal Board.

Recommendations

91. We recommend that—

(i) Different types of Pilot Washing Plant should be installed at the Fuel Research Institute without further delay to obtain evidence on the most suitable and economical types for different requirements of washed coal.

(ii) Government should take steps to explore the possibilities of Coal Washing and to set up Washing Plants at selected sites where justified.

CHAPTER VI

LIGNITE OR BROWN COAL

Indian Lignite

Review

92. In the State of Madras and in South India in general there is a dearth of coal, the shortage of supply against demand amounting to about 75,000 tons of coal per month—nearly 1 million tons per annum. The cost of coal in the area is high. At Madras it is 35 to 65 rupees per ton, depending upon whether it is rail-borne or sea-borne, the sea transport being dearer; and inland from Madras or other port it is naturally still higher, owing to additional transport and transhipment. The State of Madras depends for its power supply partly on thermal and partly on hydro-electricity. During recent drought periods there have been drastic electricity cuts, and annual losses approaching rupees 1 crore have been incurred by industries. It is clearly essential to increase the fuel and the electric supply.

93. In the neighbourhood of Neyvli, South Arcot, lignite deposits of good quality were located some years ago, and have now been partially explored and investigated. These deposits, it is estimated, amount to over 2,000 million tons. They occur along with abundant water—above and below the lignite bed—and the bed itself varies in thickness from 50 to 100 feet, and is overlain by cover of 2 to 4 times this thickness. The lignite as found contains about 50 per cent. of moisture. This is usual. In German and Australian lignites the percentage of water is often as high as 66 per cent. Most of such water can be removed by drying, either naturally or artificially. Briquetting and/or carbonization may also be adopted. The brown-coal mines of Germany and of Australia produce roughly 200 million and 7 million tons per annum respectively.

94. Not only would the development of the lignite at South Arcot provide a source of fuel for the industries of Madras and the South, it would also form the centre for large thermal power generation, and thus forge another link in the **general electrification of the railways and of industries in the South.** A proportion of the wagons now required for coal transport from the North, and from ports, would be released for other transport; and the ports themselves would be relieved of pressure and enabled to handle more goods, imports and exports. In addition, brown coal as a domestic fuel would be available, against wood now costing rupees 65 to rupees 75 per ton in the towns, and charcoal, costing rupees 280 to rupees 300 per ton. The lignite should not cost 1/10th of this last figure. It may ultimately be as cheap as black coal in Calcutta.

Composition and Analysis

95. Lignite may be regarded as immature bituminous coal; its composition lies intermediate between that of peat and that of ordinary bituminous coal. Lignites may be brown or black. When dry and pure, they usually contain from 65 to 75 per cent. of carbon, from 20 to 28 per cent. of oxygen, and about 5 per cent. of hydrogen. There are also present small amounts of nitrogen and sulphur, together about 1·5 per cent. The above values are on the basis of 'pure coal substance', *i.e.*, dry and free from mineral matter. On the

same basis, brown lignite has usually 65 to 70 per cent. of carbon, while black lignite has normally from 70 to 75 per cent., but in rare cases upto 80 per cent. Lignites (on the same pure or unit coal basis) yield 40 to 60 per cent. of volatiles, an average value being 50 per cent.

96. The calorific value of the pure dry lignite is usually from 11,000 to 12.500 Btu per lb. but in use it is less, as there is about 50 per cent. of moisture present in the lignite as mined, and 15 to 25 per cent. even in the air-dried lignite. The amount of ash is variable, but seems to lie between 3 and 10 per cent. in Indian Lignites. Taking the average calorific value for the pure coal substance as 12,000 Btu per lb. the calorific value of the lignite containing **20 per cent. inerts** (*i.e.*, moisture plus mineral matter is *some* 9,600 *Btu per lb.*). This does not seem to compare favourably with 11,300 Btu per lb. for grade II Jharia coal with 25 per cent. inert matter. The calorific value of the pure coal in the Jharia field is much higher, namely 15,500 Btu per lb. Yet, the lignite has the advantages of being free burning (non-caking), of having low ash, and of giving rapid and complete combustion. As the volatile matter is usually about 50 per cent., lignites burn readily in the powdered state, and before pulverising it is usually sufficient to reduce the moisture to 20 to 25 per cent. Lignites are particularly useful for power generation in large thermal plants. The Australian brown coal at Yallourn in Victoria is used mainly for this purpose, and provides the electric supply for Melbourne. But lignite may also be used for town's gas manufacture by employing Lurgi (pressure) plant.

97. The results of tests and analyses of the South Arcot and Palana (Bikaner State) lignites are given in Table 7.

TABLE 7

SOUTH ARCOT AND PALANA LIGNITES

Analyses made by Fuel Research Institute

	Impurities	(calorefic value) (Values are percentages except South Arcot	Palana
As Mined	Moisture	52·0	50·0
	Ash	2 65	6·0
	Sulphur	0·5	1·0
On Unit Coal*			
Proximate	Volatile Matter	55·0	52·5
	Fixed Carbon	45·0	47·5
Ultimate	Carbon	70·0	71·0
	Hydrogen	5·0	5·0
	Nitrogen	0·5	1·0
	Sulphur	1·0	2·0
	Oxygen (Diff.)	23·5	21·0
	Calorific value Btu per lb.	11,770	12,195

*Unit coal is free from inert matter, *i.e.*, from moisture and mineral mattre (inorganic). If there is 20 per cent of such inert matter in the lignite as used, the calorific values, etc. require reducing by the same amount, namely 20 per cent. The calorific values would thus be 11,770 × 80/100 and 12.195 × 80/100, *i.e.*, roughly 9,400 and 9,750 Btu (gross) per lb. respectively. The net calorific value is rather less, and its evaluation for high moisture fuels is important. It is given by the formula—net c.v. = gross c.v. $-\frac{1100(W+9H)}{100}$ Btu per lb.

The composition of the ash of a sample of South Arcot lignite also analysed at the Fuel Research Institute is as follows (Table 8).

TABLE 8

ASH OF SOUTH ARCOT LIGNITE

	Percent.
Silica-SiO_2	18·00
Alumina-Al_2O_3	21·3
Ferric Oxide-Fe_2O_3	4·13
Titanium Oxide-TiO_2	2·13
Phosphate-P_2iO_5	0·10
Lime-CaO	24·08
Magnesia-MgO	5·14
Sulphate-SO_3	24·20
Alkalies-AsK_2O	0·92
	100·00
Melting Range in mildly reducing atmosphere ... 1180°C to	1270°C

UTILISATION

98. **Combustion.**—Lignite can be burnt raw or in the form of briquettes. The large amount of water present in lignite delivered direct from the mine often necessitates special drying arrangements. It is reported, however, by the Madras Lignite Investigation Officer, Mr. H. K. Ghose, that the lignite of the South Arcot rapidly dries on exposure to air and gives a product containing some 15 per cent. only of moisure. Perhaps under monsoon conditions a higher figure is likely. In any case the air-dried lignite should be quite suitable for direct burning, and in the dry season for simple briquetting under pressure perhaps without binder. The content of waxy and resinuous material which has been found in many samples and the general properties of the lignite itself warrant experiments of this mode of briquetting. For high capacity boilers briquetting is of course unnecessary, as the fuel can be burnt in the pulverised form, or even as fine slack in spreader stokers. For local use, however, in small furnaces of all kinds or for domestic purposes, briquettes are generally preferred. If not briquetted, the raw lignite on exposure goes to slack and crumbles largely to powder. Even when briquetted some raw lignites are not satisfactory, as they distintegrate on weathering. In such cases, it is usual first to carbonise the material and use the large 'coke' direct as fuel and to convert the small 'char' into briquettes by employing as binder some of the tar obtained in the carbonisation.

99. **Montan Wax.**—In order to obtain the waxy content of the South Arcot lignite, benzene-alcohol mixtures and xylene have been used as solvents. Extracts of waxy material upto 10 or 15 per cent. of the dry lignite have been obtained; but such extracts are partly resinous and partly waxy. The amount of reasonably pure montan wax obtained is on an average about 2 per cent. of the dry lignite. The important property of montan wax in most of its varied uses lies in its hardness and in its comparatively high melting point.

100. **Low Temperature Carbonisation.**—On carbonisation at 600°C in the Gray-King Assay apparatus, the yields per ton of dry lignite (average values) were those shown in Table 9.

TABLE 9

YIELDS PER TON—SOUTH ARCOT LIGNITE (DRY)

	Average Value	
Coke (Char)	About 10 cwt.	Laboratory Assay Values.
Tar	24 to 42 gallons	
Liquor (aqueous)	About 20 gallons	
Gas (60°F and 30 inch sat)	6,000 cft.	

101. Certain tests have also been done on the low temperature carbonisation of South Arcot lignite at the Fuel Research Station, London. They stated that the yield of tar varied with the nature of the lignite, *e.g.* whether it is woody, brown, or coaly. Actual results reported were:

Woody	49.7 gallons per ton of dry lignite.
Brown	23.5 gallons per ton of dry lignite.
Coaly	18·5 gallons per ton of dry lignite.

102. The 'Char' or coke obtained at the Fuel Research Institute, Jealgora, was 'barely coherent'; it broke into powder on handling. The nature and potentialities of the tar and of the liquor, and the composition and calorific value of the gas, are at present under investigation at the Fuel Research Institute. Values for the gas composition are given in Table 10.

TABLE 10

(LOW TEMPERATURE ASSAY AT 600°C)

Constituent	% by volume	Remarks
Carbon dioxide-CO_2	45.0 to 52.0	
Olefines, etc.-C_nH_m	2·5 to 3·5	
Carbon Monoxide-CO	11·0 to 13·5	Cal. value of the gas 300 to 330 Btu/cft-gross value saturated at 60° F and 30″ Hg (ordinary coal gas has c.v. of about 500 Btu per cft.)
Methane-CH_4	17·0 to 19·0	
Hydrogen-H_2	8·0 to 10·0	
Oxygen-O_2	1·0 to 2·5	
Nitrogen-N_2	4·0 to 5·0	

Experiments are also being done on briquetting the char, using some of the tar as binder.

103. As there is no experience in India of the working, preparation and uses of Brown Coal, the following notes are given on the Brown Coal Industry of Germany and Australia to help to visualise the potentialities of such an industry in Madras.

GERMAN BROWN COAL

Review

104. In Germany, Brown Coal Deposits are found in 3 main areas:

(a) Lower Rhenish District—about 10 to 15 miles from Cologne.

(b) Central Germany in the Helmstedt District.

(c) Upper Silesia (Russian Zone of Occupation).

105. **Mining Open-Cast.**—Over 90 per cent. of the lignite is worked by open-cast methods, using machinery specially designed and developed for the purpose. The seams are often of great thickness (average 180 ft.), overlain with about half this thickness of soft over-burden (Cologne District), although the ratio of over-burden to coal increases up to 1:2 or more in certain places. The seams are horizontal.

106. The coal as worked contains 60 per cent. moisture, and forward or advance preparation to remove water from the strata is necessary. The over-burden consists of sandy gravel, sandy loam, and sand, with occasional clay.

107. Various types of specially designed mechanical excavators are in use; the layout is carefully planned, in order to cut and transport effectively not only the lignite but also the over-burden and to replace the latter.

Composition and Analysis

108. The composition of the South Arcot and Palana lignites is similar to that of the Brown Coals of Germany (and Australia) and the potentialities of an Indian brown coal or lignite industry may be gauged from the following particulars of the German Brown Coal Industry, taken largely from recent Reports of British Intelligence Objectives Sub-Committee (B.I.O.S.).

Table 11

COMPOSITION OF GERMAN BROWN COALS

	Central Germany		Rhineland	
	As received	Unit coal	As received	Unit coal
Ultimate analysis				
Carbon %	28-31	68·0	24-28	66·0
Hydrogen %	2-3	5·5	1-3	5·0
Oxygen %	7-10	24·5	8-14	27·5
Nitrogen %				
Sulphur %	1-1·5	2·0	0·2-1	1·5
Ash %	3-8	...	0·8-2·5	..
Moisture %	47·55	...	56-64	...
Heating Value				
Gross wet, Btu/lb.	4,310-5,220	11,600	3,960-4,680	11,300
Net wet, Btu/lb.	3,600-4,500	..	3,260-3,960	..

UTILISATION

109. The brown coal is utilised for:—

(a) Thermal Stations near the mines for the production of electric power,

(b) Manufacture of briquettes for industrial and domestic use;

(c) Low Temperature Carbonisation for the production of petrol, light oils, tar, and coke; and

(d) Gasification in Lurgi or Winkler plant or the like, either for the making of synthesis gas or for producing town gas.

The magnitude of the industry can be seen from the figures given in Table 12 (B.I.O.S. Final Report No. 734).

TABLE 12

USE OF GERMAN LIGNITE

Uses	1938		1942	
	Million tons.	Per cent.	Million tons.	Per cent.
Electric Power	45·0	23·2	85·0	32·5
Household	72·5	37·3	72·0	27·4
Mine*	16·6	8·5	21·0	8·0
Chemical	15·0	7·7	18·0	6·7
Low Temperature Carbonisation	(para. 113 below)	...	(para 113 below)	9·5
Metallurgical	8·5	4·4	9·0	3·4
Glass and Pottery	6·9	3·6	5·0	1·9
Textiles	5·7	2·9	5·0	1·9
Building materials	5·4	2·8	4·0	1·5
Paper	5·3	2·7	4·0	1·5
Sugar	2·7	1·4	3·0	1·1
Other uses	10·6	5·5	12·0	4·6
TOTAL	194·2	...	238·0	...

*Estimated at 8·5% of total production.

110. For combustion the raw coal may be dried to 20 per cent. of moisture and used direct either in pulverised form or in spreader stokers in large thermal plant. For briquetting the raw coal is crushed to ¼ inch and passed through (steam heated) 2 inch pipes in drying chamber-drums, generally 25 feet long and set at 20° to the horizontal and rotated. On drying, the brown coal breaks to still smaller sizes and to dust, while the moisture is reduced to 15 per cent. The dried powdered coal then passes to the pressure briquetting presses (7 tons per sq. inch). Two main forms of briquette are made—1 lb. and ⅓ lb. No binder is necessary. The briquettes are air-cooled before stacking. Precautions are necessary against dust explosions, and electrical precipitators are often used to remove the dust. The following comparison is given:—

	Raw Brown coal	Brown coal briquetted
Moisture	60%	15%
Ash	2·4%	5%
Net Calorific Value	3,420 Btu/lb.	8,600 Btu/lb.

111. The brown coal briquette has a lower calorific value and lower specific gravity than average bituminous steam coal. Consequently it is not generally used for railway locomotives; otherwise, brown coal briquettes entirely replace bituminous coal in many parts of Germany for light, heat and power, for both domestic and industrial uses.

112. **Low Temperature Carbonisation.**—In 1938 low temperature carbonisation processes consumed about 26 million tons of brown coal (13 per cent.), this quantity being concealed in the 70 million tons estimated to have been consumed by electric power, the chemical industry, and other uses.

113. Total consumption for low temperature carbonisation in 1942 is estimated at 51 million tons (nearly 20 per cent), 26 million tons being concealed as in 1938. Estimated increased consumption as compared with 1938 was made up as follows:—

	Million tons.
Low temperature carbonisation	15
Fischer-Tropsch Process	6
Hydrogenation process	4
	25

114. Not all types of brown coal are suitable economically for low temperature carbonisation. In general the brown coal of the Lower Rhenish district (Cologne and Duren) is unsuitable, while that of Central Germany (Helmstedt) is satisfactory. The lignite is sometimes briquetted before carbonisation.

115. The costs of mining, pumping, and all processing are not high; the coal is mined at a cost (1952) of rupees 45 per ton briquettes are sold at rupees 17 per ton f.o.r. plant. These low cost figures, especially for mining, are obtained through extensive mechanisation, and the use of large specially designed machinery with suitable layout. The output per man shift is as high as 13 tons.

AUSTRALIAN BROWN COAL

REVIEW

116. The reserves of recoverable brown coal in Australia (Victoria) are estimated to be 37,000 million tons. The brown coal deposits of Victoria are located largely at Yallourn, about 100 miles east of Melbourne. Some of the seams are extraordinarily thick, one at Loy Yang, near Traralgon, being 803 ft. covered by only 60 ft. of overburden. At Yallourn, the moisture in the coal is usually 60 to 63 per cent. in the upper seam and 58 to 63 per cent. in the lower seams.

117. According to F. H. Roberts (Transactions of the Fourth World Power Conference, London, 1950) the coal is of four main types—earthy, lignitic, ferny, and pollen. The earthy type is a chocolate coloured coal without a definite structure; the lignitic has a definite woody fibrous structure, and retains the texture and often the shape of tree trunks and logs, some of which are as much as 5 ft. in diameter. Ferny coal is derived from ferns similar in type to those at present occurring in southern Victoria, while pollen coal occurs as a layer of fossilized pollen, sometimes several feet in thickness.

118. The overburden at Yallourn is generally from 25 to 50 ft. thick, while the coal seam is about 200 ft. thick. The coal is worked by two bucketchain deep dredgers, each capable of working a depth of 90 ft. of coal at the rate of 500 tons per hour. Electric shovels are employed to take a levelling out for the uneven top surface of the coal and a bucket-wheel dredger is at present being erected. The cost of mining is as low as rupees 2·0 per ton.

119. The overburden, removed by a dredger and shovels, is conveyed by electric trains to a ditch bunker, from which it is returned to the worked out portion of the Open Cut by means of the overburden spreader. Coal transport (also by electric train) delivers the lignite to special bunkers, from which it is transported by conveyor belts to the power station or to the briquetting factory.

120. The Open Cut at Yallourn now produces over 6 million tons of coal per year, and according to estimates it will yield about 10 million tons in 2 or 3 years.

121. The magnitude of the Australian Brown Coal industry is suggested by the fact that 7 million tons of coal are mined per annum. The figures in the statement on pages 49 & 50 taken from the annual Report for 1950-51 of the State Electricity Commission of Victoria are also instructive, and show the expenditure involved.

STATE ELECTRICITY COMMISSION OF VICTORIA

Features of 1950-51 Operations

		1950-51	1949-50	Increase or Decrease	Percentage
FINANCIAL					
Income—					
Electricity Supply	£	11,524,389	9,446,008	+2,078,381	+22·0
Briquetting (after Stock Adjustment and less Sales to Works)	£	520,052	436,862	+83,190	+19·0
Brown Coal (less Sales to Works)	£	203,418	244,100	—40,682	—16·7
Tramways	£	175,063	171,504	+3,559	+2.1
Miscellaneous	£	31,576	40,183	—8,607	—21·4
	£	12,454,498	10,338,657	+2,115,841	+20·5
Expenditure—	£	12,452,638	10,688,025	+1,764,613	+16·5
Profit or Loss	£	P. 1,860	L. 349,368	...	...
Transfers from Reserves	£	...	100,000	...	...
Net Surplus or Deficit	£	S. 1,860	D. 249,368	...	...
Capital Expenditure—At end of year	£	93,096,608	61,358,803	+31,737,805	+51·7
Reserves—At end of year	£	19,308,612	18,200,424	+1,108,188	+6·1
ELECTRICITY PRODUCTION AND SALES.					
Maximum coincident Demand on Power Stations. (25th July, 1950)	KW	497,370	504,090	—6,720	—1·3
Electricity Generated—					
50 Cycle	Kwh-millions	2,518·5	2,362·3	+155.7	+6·6
25 Cycle (Newport "A" Station acquired 21/1/51)	Kwh-millions	87·0	...	...	...

STATE ELECTRICITY COMMISSION OF VICTORIA

Features of 1950-51 Operations—contd.

		1950-51	1949-50	Increase or Decrease	Pereentage
Electricity Sales—					
General Supplies	Kwh-millions	2,030.6	1,880.2	+150.4	+8.0
Railway Supplies	Kwh-millions	70·7	...	...	...
Number of Consumers (excluding Bulk Supplies)		415,682	391,005	+24,677	6.3
Average Kwh Sold per Consumer—					
Domestic		1,566	1,550	+10	+0·6
Industrial		39,529	35,550	+3,979	+11.2
Commercial		3,817	3,555	+262	+7.4
All Consumers (excluding Bulk Supplies)		3,577	3,313	+264	+8.0
Average price per Kwh sold—					
Domestic	d.	1.679	1.554	+0.125	+3·6
Industrial	d.	1.178	1.041	+0.137	+13.2
Commercial	d.	2.178	2.148	+0.030	+1.4
All Consumers (excluding Bulk Supplies)	d.	1.495	1.392	+0.103	+7.4
Motors Connected—					
Number		101,988	96,156	+5,838	+6.1
Horse Power		565,298	528,618	+36,680	+6.9
Number of Farms served		17,572	15,741	+1,631	+11.6
Briquettes—					
Produced	Tons	511,404	588,864	—77,160	—13.1
Sold and used at Power Stations	Tons	503,613	580,173	—76,560	—13.2
Yallourn Open Cut—					
Brown Coal Won	Tons	6,056,331	6,404,059	—347,728	—5·4
Yallourn North Open Cut—					
Brown Coal Sold	Tons	688,374	764,911	—76,537	—10.0
Tramway Passengers		13,738,274	14,213,525	—475,251	—3.3

122. **Features of 1950/51 Operations.**—The electricity sold to all consumers, including bulk supply, and electricity supplied to the Victorian Railways totalled 2101 million kw hr. The cost of mining the coal is roughly 2 shillings per ton, *i.e.* about rupees 1¼. It will be realised that the **Australian conditions of mining are far more favourable in as much as the seams in Victoria are thicker and overburden much less than in South Arcot.** The reserves of coal in Victoria are also roughly 20 times those estimated for South Arcot. In Australia distillation (*i.e.* carbonisation) of some of the lignite has also been carried out, and is now being extended.

123. Behind the development of the Australian Lignite is a long period of years. It was first exploited as far back as 1860, but it was not until plans for the electrification of suburban railways were brought forward in 1912 that the matter received serious consideration by the Government and it was not until 1920 that the present State Electricity Commission was formed. As stated, the briquetting capacity is being increased, and it is hoped eventually to produce 2½ million tons of briquettes per annum. The Australian lignite does not seem to have sufficient Montan wax to make the recovery of this by-product worthwhile. The complete gasification of the lignite, however, is under way for Melbourne gas supply, and orders have been placed for Lurgi (pressure) plant for making town gas for this purpose.

COMPOSITION AND ANALYSIS

124. The composition of the brown coals from the existing Yallourn Open Cut and from the cut at present being opened up at Morwell are shown in Table 13.

TABLE 13

COMPOSITION OF VICTORIAN LIGNITIES (AUSTRALIA)

	Victorian Brown Coals			
	Yallourn		Morwell	
	As received	Unit Coal	As received	Unit Coal
Ultimate analysis				
Carbon %	22·10	67·6	24·83	69·5
Hydrogen %	1·56	4·8	1·54	4·3
Oxygen %	8·78	26·8	3·76	24·6
Nitrogen %	0·18	0·6	0·21	0·6
Sulphur %	0·08	0·2	0·11—0·59	1·0
Ash %	0·80	...	0·92—2·22	...
Moisture %	66·50	...	63·0	...
Heating value				
Gross wet, Btu/lb.	3,710	11,400	4,292	12,100
Net wet, Btu/lb	2,860	...	3,480	...

125. It will be seen that the Yallourn and Morwell coals have only 1 to 2 per cent. ash. Typical ash analyses are as follows (Table 14).

TABLE 14

ASH OF YALLOURN AND MORWELL COALS

	Yallourn	*Morwell*
Silica—SiO_2	2·5—6	2·3—18·5
Alumina—Al_2O_3	4—12	5·6—20·1
Iron Oxide—Fe_2O_3	25—40	4·4—23·2
Magnesia—MgO	17—18·5	7·7—16·1
Lime—CaO	11—14	
Alkali (Soda)—Na_2O	4—5	2·2—12·7
Potash—K_2O	1—1·5	
Sulphate—SO_3	13—17	18·2—14·5
Chloride—Cl_2	0·5—1·5	...

The low ash proved a source of difficulty when Yallourn brown coal was burned in the form of briquettes, as there was insufficient ash to protect the grates from overheating during the combustion process. In fact, the ash discharge from travelling grates burning Yallourn briquettes is negligible.

126. **Moisture.**—A characteristic feature of all brown coals is their high moisture content. This moisture can be removed by heating, but if the dried brown coal is left exposed, it will regain moisture from the water vapour in the air until an equilibrium, approximating to 15 or 20 per cent. moisture, is reached.

127. **Combustion.**—The coal is utilised direct in the wet state as mined, after crushing and after partial drying. It is used both in the granular form and in briquettes. The raw coal is used generally near the mine, to save transport of water, and to avoid disintegration of the larger pieces. It is burnt in mechanically actuated step-grates with pre-drying shafts in the furnace to preheat the coal and remove moisture. Alternatively, the partly dried raw coal may be pulverised, and the boiler fired in this manner. The efficiency of steam-raising is about 70 per cent. using net calorific value as the basis of heat available.

128. Pulverised lignite is also being tested on the Victorian Railway Locomotives special container-wagons (sealed) having been designed to carry the fuel.

GENERAL COMBUSTION DIFFICULTIES

129. In utilising lignite in boilers which have been designed for bituminous coal, certain difficulties are encountered, but broadly speaking, the change-over can be effected satisfactorily if attention is given to mitigating the effects of the large quantity of moisture present, in respect of **ignition, combustion, heat-transfer,** and volume of steam in the flue gases.

130. The main difficulty caused by the high content of water in the fuel arises in the ignition of the lignite and in the propagation of the fire through the fuel bed. Some "surface" of the wet fuel entering the furnace has to be dried before ignition can take place, and, the more water the fuel contains, the more heat must be radiated back on to the fuel from the hot brickwork (or from the furnace) to drive off the upper layers of moisture from the fuel and thus allow of ignition. After the fuel "surface" has been ignited, propagation of the fire down into the body of the fuel must take place; this is again difficult, owing to the moisture there and also because a part of the heat of combustion has to be used in evaporating such water.

131. Another difficulty with wet lignite is the increased load on the induced draught fan, arising from the large volume of steam in the stack gases, which in practice may contain as much as 15 per cent. of water vapour (steam). Indeed, the large volume of fuel and gases (volatiles) to be handled somewhat decreases the capacity of the boiler, unless stokers and fans of ample size are installed. Lignite is sometimes mixed with ordinary coal for combustion and with advantage, as excessive quantities of wet fuel tend to make a boiler sluggish in operation and slow in picking up load. But, if the brown coal or lignite is first dried to a moisture content of 20 per cent. maximum, most of the above difficulties disappear, even with plant designed to burn black coal.

CONCLUSIONS

132. The brown coal production of Germany is roughly at the rate of 200 million tons per annum, six times the total output of black coal in India. The Australian brown coal production is far less, and amounts to only 7 million tons per annum, though it is increasing rapidly. Comparatively, the South Arcot lignite deposits are small, and it would not be wise to expect an annual production from these deposits, in the course of next 5 to 10 years, of more than 1 to 1½ million tons. **The lignite of South Arcot is essentially of the same nature and composition as the Australian brown coal of Victoria and is very similar to much of the brown coal of Germany.** It may thus be utilised in similar ways. The mining of the South Arcot lignite presents difficulties in respect of artesian water above and below the lignite bed, and as the overburden in South Arcot is thicker, more tough and clayey, it is likely that the mining costs will be comparatively high. **Nevertheless, the South Arcot lignite, dried and processed, should be obtainable at a price for lower than that of black coal in Madras at present. The clays in the overburden also have an economic value.**

133. **The main fields of utilisation of Madras Lignite will no doubt be similar to those of the German and Australian lignites, namely**

(i) **raw coal for thermal power stations near the mines,**

(ii) **briquettes for general industrial and domestic fuel,**

(iii) **carbonisation with by-product recovery and hydrogenation of tar to petrol etc., and**

(iv) **gasification into synthesis gas for liquid fuel—or into towns gas.**

Lignite can be efficiently used in large thermal electric generating plants. Accordingly, generating plants should be installed to support the hydro power in the Madras State, against the seasonal fluctuations and drought. **This will stabilise power available on the grid and thereby foster industrial development of the South and also facilitate railway electrification.** Lignite usually needs to be briquetted for use in existing (small) hand-fired stationary and other boilers, (including locomotives) and for domestic purposes, **Briquetting potentialities should accordingly be considered and explored.** Whether montan wax is recovered will depend largely upon its market value and the economics of its recovery.

134. The tar (a by-product of carbonization), if not required for briquetting, can be hydrogenated to give petrol and fuel oils, and the surplus char can be gasified to synthesis gas, and additional hydro-carbon oil (*e.g.* petrol) then produced by Fischer-Tropsch synthesis. Blends of the two fuels (hydrogenated tar and Fischer-Tropsch oils) have advantages. Whether hydrogenation of the tar and/or Fischer-Tropsch synthesis can be developed will depend mainly on the cost of mining the lignite.

135. If there is a demand for gaseous fuel in the South, whether for domestic or industrial purposes, it can be met satisfactorily by complete gasification of the lignite under pressure as in Lurgi plant. If there is a shortage of fertilizer, the gas obtained by direct or indirect gasification may become a useful source of hydrogen for the production of ammonium salts.

136. **In a word, the great potentialities of the lignite in the South of India should be explored, and adequate finance and technical skill should be made available, so that the costs of mining and processing may be kept to the minimum.** Successful exploitation and development of the South Arcot lignite and installation of electric generating plant **will, however, give only partial relief to the fuel needs of the South and will not completely solve the fuel problems of that area. The requirements of black coal for the South will still be considerable** for locomotive and industrial purposes (See para. 223, Chapter X), and will need to be met from outlying fields, particularly the Singareni Coalfields.

RECOMMENDATIONS

137. We recommend that—

(i) High priority should be given by Government to the mining and exploitation of the lignite of South Arcot and to the establishment of thermal generating plant and of industries in the vicinity of the mines,

(ii) Steps should be taken to draw upon the experience and knowledge of Brown Coal Mining in Germany, where the problems of water infiltration and handling have been solved,

(iii) Selected Mining Engineers from India should be sent to gain experience of the methods employed in working the Brown Coals of Germany and of Australia, and

(iv) Research should be undertaken into (a) the best methods of using the lignite in locomotives (including Gas Turbine Type) and in Industrial Plants, and (b) the problems of Briquetting, Gasification, Carbonisation and Hydrogenation.

PART III

SUPPLY & TRANSPORT

CHAPTER VII—LOCO COAL REQUIREMENTS AND A RATIONAL BASIS OF ASSESSMENT.

CHAPTER VIII—EXISTING CONDITIONS OF SUPPLY AND DISTRIBUTION OF LOCO COAL.

CHAPTER IX—PROPOSED PLAN FOR SUPPLY AND DISTRIBUTION OF COAL.

CHAPTER X—PLAN FOR SUPPLY OF COAL TO THE SOUTH.

CHAPTER XI—TRANSPORT DEFICIENCIES.

CHAPTER VII

LOCO COAL REQUIREMENTS AND A RATIONAL BASIS OF ASSESSMENT

EXISTING RAILWAY PRACTICE

Review

138. Replies to our questionnaire show that Railways, as a rule, base their requirements for different grades of coal on the importance they assign to different services, the scheme generally followed being—

(i) rail and express services—Selected grades.

(ii) passenger and fast goods—Grade I.

(iii) slow goods and shunting services—Grade II.

This practice ignores the important fact that fuel consumption in locomotives is directly governed by requirements of steam generation and types of locomotives used. For instance, the steaming requirements of goods services are as heavy as, in fact heavier than, those of the passenger services. Many locomotives employed in goods services are still of the BESA category and boiler research has shown that these locomotives should be given highest grades of caking or non-caking coals. The railways, however, allot grade I coals to the BESA locomotives used on goods services, and the result is an increase in coal consumption of 10 to 15 per cent.

Quality and Consumption

139. The Committee considers that greater economies in the utilisation of coal in a locomotive can be obtained if coals are assigned not on the basis of 'services' but on the basis of their suitability for the different designs of the locomotive boiler. This is a rational approach and envisages the development of a scientific relationship between the grade of coal and the design of locomotive boiler through experiment and research.

140. During the course of our enquiries we found that there was an impression amongst some members of the coal trade that the greater use of higher grade coals made little difference to engine performance. In support of this view they quoted fuel consumption statistics (in lb. per thousand gross ton miles) based on service units, such as "passenger and proportion of mixed" and "goods and proportion of mixed". They did not, however, seem to appreciate that the consumption unit (lb. per thousand gross ton miles) is affected by several factors over and above the quality and size of coal. Some of these factors are, locomotive utilisation, loads, speeds, gradients, detentions to trains, firing technique, mechanical condition of power and rolling-stock, boiler drafting conditions, and the proportion of

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caking and non-caking coals used. It is because of these factors that, although loco coal supplies deteriorated in quality during the war, the coal consumption did not show much increase in terms of "lb. per thousand gross ton miles". For instance, during the war, the quantity of traffic handled per engine mile was comparatively greater and the average train speed was relatively lower (see Appendix 8). These two factors contributed to reduction in consumption of coal—the bigger loads by giving a greater degree of utilisation of locomotive power and lower speeds by reducing tractive resistance.

141. Further, the consumption of coal in lb. per thousand gross ton miles suddenly increased during the years 1947 to 1949 in spite of the fact that grade III coal was excluded from loco coal supplies and the proportion of grade II coal was also reduced. This fact is often quoted to prove that the amount of ash in coal makes little difference to engine performance. We are, however, of the opinion that this sudden increase in coal consumption was partly due to some of the factors mentioned in the foregoing paragraph, but it was largely due to the loss of experienced engine crew and maintenance staff who had migrated to Pakistan on the partition of the country. The process of restoring normal railway working was further retarded by stores deficiency caused by war conditions. The result was poor maintenance and operation of locomotives and other rolling stock, causing increased coal consumption.

142. It has also been pointed to us that the ex. Nizam's State Railway using Singareni coal (which is between grade I and grade II quality, based on the present grading scheme), has achieved better performance than other railways using higher grades of coal. This observation has been quoted in support of the contention that the grade of coal does not materially affect the overall fuel consumption figures. The fact, however, is that the ex. Nizam's State Railway has used coal consistent in quality and size (slack and dust not exceeding 10 per cent.) though inferior in grade according to the present grading scheme. This consistency in quality and size has allowed correct drafting of the locomotive furnaces, which is one of the most important factors in reducing loco coal consumption. Moreover, other factors such as loads, speeds, train control conditions, standards of workmanship etc., remained unaffected by the partition of the country in the case of the ex. Nizam's State Railway and good discipline was maintained throughout.

143. Nevertheless, the consumption of coal per thousand gross ton miles is the criterion of the economic use of coal in rail transport. If this figure is comparatively high and if the rise cannot be precisely assigned or explained, the indication is that the fuel cost for traffic moved is high, and that there is inefficiency in utilisation for one cause or another. The fuel consumption 'lb. per thousand gross ton miles' on the major railways since 1941 has been high both for goods and for passenger traffic, and in addition to the causes enumerated above, it would seem that lack of attention to the organisation of the fuel supplies and consumption is a contributing factor. Uneconomic utilisation of locomotive power, such as employment of

heavy locomotives on lighter services or goods locomotives on passenger services, may also lead to increased coal consumption in term of lb. per thousand gross ton miles. Later in this report we have investigated these matters more fully and suggested methods for improving the training of staff and for the better organisation and control of fuel supplies and consumption in locomotives. **It is needless to emphasise that with efficient operation and control, the greater the ash in any coal, the heavier will be the consumption for that particular type of coal.**

RATIONAL BASIS FOR LOCO COAL REQUIREMENTS

Loco Boiler Design and Grade of Coal

144. **Research.**—The Central Standards Office for Railways has in the past 15 years carried out much research on locomotives with the help of Dynamometer Car, and has amassed extensive information on locomotive furnace and boiler performances. The Central Standards Office has submitted for our examination six notes on 'A Review of the Fuel Problem on Indian Railways'. These notes are given in Appendix 9. We shall refer to notes (1) and (2), which provide a study of the combustion conditions with caking and with non-caking coals as used in each of the four categories of locomotives described below:—

(i) The British Engineering Standards Association (BESA) designs, introduced on Indian Railways about the year 1915.

(ii) The Indian Railway Standard (I.R.S.) designs, introduced in the year 1926.

(iii) The recent I.R.S. designs which have come into use since 1948.

(iv) All types of locomotives employed in shunting duties.

145. The annual consumption of coal in locomotives is of the order of 8·8 million tons, which is 83·5 per cent. of the total railway supplies. Table 15 gives the approximate number of existing locomotives in each of the above mentioned categories and their annual coal consumption.

Table 15

NUMBER OF LOCOMOTIVES AND THEIR ESTIMATED ANNUAL COAL CONSUMPTION IN EACH CATEGORY

Category of Locomotives	Locomotive power on Indian Railways		Estimated coal consumption.	
	Number	Percentage of total	Million tons	Percentage of total
BESA designs	3,797	45·9	4·22	48·0
1926 IRS designs	2,104	25·5	2·63	29·9
Recent IRS designs	678	8·2	0·90	10·2
Shunting Locomotives	1,684	20·4	1·05	11·9
Total	8,263	100·0	8·80	100·0

146. The Central Standards Office notes contain specific recommendations regarding the suitability of each grade of coking or non-coking coal for locomotives in the above four categories. We are generally in agreement with these recommendations and record them below.** The word 'COKING' however, should read as 'CAKING' or 'SEMI-CAKING' in sections (i) to (iv) below, and we have modified the sections accordingly.

(i) BESA LOCOMOTIVES—should normally be given to burn selected grade 'caking' or 'semi-caking' coals. These locomotives can burn medium grade (grade I) caking or semi-caking coals and can produce the power required for operating scheduled services, but there will be a certain loss in efficiency which in any given service may cause an increase in coal consumption of the order of 10 *to* 15 *per cent.*

(ii) 1926 IRS DESIGNS—should normally be given to burn medium grade (grade I) caking or semi-caking coals. These locomotives can burn medium grade non-caking coals or low grade (grade II) caking coals and produce the power required for operating scheduled services, but there will be a certain loss in efficiency which, in a given service, may cause an increase in coal consumption of the order of 20 *to* 25 *per cent.*

(iii) LATEST IRS WP/WG and YP/YG DESIGNS (1948)—should normally be given to burn medium grade (grade I) non-caking coals. These locomotives can burn low grade non-caking coals (calorific value 10,500 to 10,700 Btu per lb. and ash content upto 24 per cent.) and produce the power required for operating scheduled services, but there will be a loss in efficiency which, in a given service, may cause an increase in coal consumption of the order of 15 *per cent.*

(iv) LOCOMOTIVES EMPLOYED IN SHUNTING DUTIES—irrespective of the types used, these locomotives should normally be given to burn grade I coals preferably of the caking varieties. Coals below grade I will cause considerable wastage through the chimney and the grate,

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**A caking coal is one which, on heating, goes through a pasty state and leaves a coke consisting of fixed carbon and ash. Coking coal is a caking coal which leaves a tough hard coke suitable for blast furnace purposes, low in sulphur and phosphorus, and containing not more than about 22 per cent. of ash. This refers to Indian practice. In Europe, U. S. A. and other countries, the maximum ash permissible in metallurgical coke is of the order of 10 per cent. 'Caking' and 'Coking' are often confused with clinkering. Clinkering arises from melting of the ash on the fire-bed. Some coals contain foreign matter (ash), which melt at a comparatively low temperature, say, 1100°C. Other coals (the majority of coals in India) give ash which melts at a high temperature often over 1350°C. A low melting point in ash is usually and naturally associated with clinkering.

Clinkering is highly objectionable in locomotive coals as it prevents the flow of air through the fire-bed, so that in extreme cases the locomotive has to stop for several hours while the fire is cleaned out, to the complete disorganisation of the service.

The caking of coal retards the air flow somewhat, but as the carbon of the coke burns away, the flow of air through the fire-bed is naturally restored unless the ash is excessive.

and firing to meet heavy fluctuations obtaining in combustion rates in shunting duties is both difficult and onerous.

Note.—The BESA an the earlier IRS locomotives which have been designed to burn high and medium grade caking coals, respectively, can accept non-caking coals of the corresponding grades without loss in power but with a less in efficiency, resulting in an increase in coal consumption on an average of **15 to 20 per cent.**

STATIONARY VERSUS LOCO BOILERS

147. **Service Performance Tests.**—We have before us figures for the consumption of each grade of coal in locomotive and stationary boilers under given conditions (*i.e.* when producing a given quantity of steam). These figures are reproduced in Appendix 6. Answers to the questionnaire also contain service performance results on locomotive boilers. Table 16 gives an extract of these results in a comparative form.

TABLE 16

UNITS OF RELATIVE CONSUMPTION WITH DIFFERENT GRADES OF COAL

Grade of coal	Stationary boiler	Locomotive Boiler				
		CSO for Rlys.		E. I. Rly.	GIP Rly.	Southern Rly.
		Old BESA	New IRS			
Selected 'A' (12750 Btu/lb.)	100	100	100	100	100	100
Selected 'B' (12200 Btu/lb.)	105	107	107	110	...	111
Grade I (11700 Btu/lb.).	111	120	115	125	126	...
Grade II (10800 Btu/lb.)	122	140	130	145	148	142

148. The figures in table 16 show that the consumption of coal in stationary boilers does not increase as fast as consumption in locomotive boilers with the reduction in quality of coal. In fact the performance of the stationary boilers with grade II coals is more or less equal to that of the locomotive boilers with grade I coals. The explanation for the relatively poorer performance of the locomotive boiler lies in the fact that the latter is restricted in furnace proportions. The locomotive on rails has to keep within the axle load and gauge restrictions, and can be designed to have, at the very best, a grate area of only one-third to one-half and a furnace volume of only one-fourth to one-fifth of the proportions generally given to a stationary boiler of the same steam generating capacity.

149. The smaller grate of the locomotive has thus to carry a higher firing rate of 60 to 80 lb. per sq. ft. of grate area per hour as against 25 to 35 for a stationary boiler in normal working. The

smaller furnace volume is responsible for the relatively less time that volatile matter and small coal particles (burning in suspension) stay in the combustion space while burning. Both effects combine to increase the incomplete combustion losses of the locomotive boiler. Hence the advantage, which the stationary boiler possesses over the locomotive boiler in the matter of performance with different grades of coals **particularly the lower grades.**

150. Shunting locomotives have a lower boiler rating, which is generally comparable with that of a stationary boiler (firing rates 25 to 35 lb. per sq. ft. of grate area per hour), and it has been argued that these locomotives should be able to use coals of grade II quality as efficiently as stationary boilers can.

This argument is not supported by the statistical figures of actual consumption of grade I and grade II coals on shunting locomotives furnished in Appendix 10. The figures show that the consumption on shunting locomotives with grade II coals averages from 80 to 90 lb. per engine mile on the Broad Gauge and 50 to 60 lb. per engine mile on the Metre Gauge. The corresponding figure for grade I coals are 45 to 55 lb. per engine mile on the Broad Gauge, and 30 to 40 lb. per engine mile on the Metre Gauge. **The explanation is that, although the average working of the shunting locomotive (over the period of duty hours) is light, there are fluctuations in shunting duties every few minutes which cause a swing in the combustion rates from nil to 100/150 lb. per sq. ft. of grate area per hour. These requirements of shunting duties cannot be met efficiently by grade II coals.**

151. **Design Limitations.**—There is an impression in some quarters that the recent IRS designs of locomotives—WP/WG for the Broad Gauge and YP/YG for the Metre Gauge—are capable of burning grade II coals with the same efficiency as is attainable when burning higher grades coals. **This is a misapprehension.** The fact is that the new IRS locomotives were primarily designed to burn high volatile non-caking coals in place of caking coals. Such non-caking coals should, however, have a calorific value of at least 11700 Btu/lb. and as ash content of not more than 20 per cent. **With grade II coals (ash 24 per cent.) the power of these locomotives is not affected, but the coal consumed will be about 15 per cent. more than with grade I coals.**

152. As stated earlier, the size and proportions of the locomotive boiler are subject to design limitations. Axle-load restrictions entail the provision of more axles (wheels) to accommodate a boiler of the massive proportions needed for efficiently burning low grade coals. Such enhanced proportions increase the weight of the locomotive and thereby reduce the load that can be handled by it. Concentration of more weight in a locomotive also involves strengthening of bridges and track. **This introduces economic factors which militate against the adoption in locomotive design of the massive boilers and furnaces needed for burning grade II coals with high efficiency.**

AVAILABILITY OF GOOD QUALITY COALS

Reserves and Supplies

153. There are extensive reserves of moderate to good quality (grade I and above) non-caking coals in the Raniganj and Karanpura fields, and in the outlying fields of Vindhya Pradesh and Madhya Pradesh. This view is confirmed by the Coalfields Committee's Report, 1946, and the Coal Working Party Report, 1951. As many of the coals need grading and as some of the fields have been only partially explored, it is not possible to furnish firm figures for these reserves.

154. With regard to the present output, however, the raisings from the different coalfields in the year 1950-51 of caking and non-caking coals (down to grade II quality) are shown in table 17. Though approximate, these figures are indicative of the amounts and proportions of the four grades of coals now being raised and supplied.

TABLE 17

APPROXIMATE OUTPUT OF COALS (EXCLUDING GRADE III) FOR THE YEAR 1950-51

(In million tons)

I. Caking coals—Bengal and Bihar Coalfields.

Coalfield	Selected 'A' & 'B'	Gr. I	Gr. II	Total
Raniganj	0·74	0·14	0·05	0·93
Jharia	5·67	0·80	2·92	9·39
Bokaro and Karanpura	0·39	1·40	0·17	1·96
Giridih	0·45	...	...	0·45
TOTAL	7·25	2·34	3·14	12·73

II. Non-caking coals—Bengal & Bihar Coalfields.

Coalfield	Selected 'A' & 'B'	Gr. I	Gr. II	Total
Raniganj	6·68	1·24	0·40	8·32
Jharia	0·62	0·09	0·32	1·03
Bokaro and Karanpura	0·16	0·60	0·07	0·83
Giridih	...	...	...	...
TOTAL	7·46	1·39	0·79	10·18

III. Non-caking Coals—Outlying Fields.

Coalfield	Selected 'A' & 'B'	Gr. I	Gr. II	Total
CIC, Pench and Chanda	...	1·98	1·98	3·96
Singareni	...	0·6	0·6	1·20
Talcher	...	0·42	0 24	0 48
Assam	...	0·23	0·23	0·46
TOTAL	...	3·05	3 05	6·10
Grand total of Tables I, II and III	14 71	7·32	6·98	29·01
Percentage	(50·7)	(25·2)	(24·1)	(100·0)

NOTE.—The breakdown of figures in table 17 is based on the following approximate assumption.

	Caking	Non-caking
Bengal and Bihar fields.		
Raniganj	10%	90%
Jharia	90%	10%
Bokaro & Karanpura	70%	30%
Giridih	100%	...
Outlaying fields.		
All outlying coals (Mainly Non-caking)	50%	50%

NOTE. Coals from outlying fields are not yet graded officially. For these fields grade II coals may be taken provisionally as coals having from 20 to 24% ash on a dry basis.

155. Table 18 gives an idea of the distribution of the four grades of coals to the railways, industries, and export market in the year 1950-51.

TABLE 18

APPROXIMATE DISTRIBUTION OF COAL FROM BENGAL AND BIHAR FIELDS EXCLUDING GRADE III IN 1950-51

(Million tons)

Name of Industry	Selected 'A' and 'B'	Grade I	Grade II	Total
Loco	3 64	2·68	1·09	7·41
Export	1·25	...	...	1·25
Steel	3·36	0·22	...	3·58
Other Industries	6 46	1 37	2·34	10·17
TOTAL	14 71	4·27	3 43	22·41

It would appear that there is ample production of high grade non-caking coals suitable for railway use, and that a programme for replacement of caking coals by non-caking coals in railway supplies is practicable. There are, however, certain difficulties. First, the grades as stated today for coals raised in the various coalfieds often do not correctly represent the quality in actual supplies; some seams of coal have deteriorated, and some have been exhausted since they were graded. Secondly, owing to transport difficulties, it is not yet possible to move non-caking coals (specially of the Raniganj coalfields) to the Northern areas and this retards the policy of replacing caking roals by non-caking coals. In the circumstances, such replacement will have to be spread over a number of years to afford time for the necessary development of transport and to open up new collieries, if required, in the non-caking coalfields.

WORKABILITY OF THE RATIONAL BASIS

Illustrative Plan

156. We have shown, as an illustration, in table 19 (page 67) the coal requirements of certain major railways on the basis indicated in para 146. Four 'alternative schemes' have been considered to cover the transition from 100 per cent. caking to 100 per cent. non-caking coals. This is subject to solution of the difficulties indicated in para. 155, above. Alternative 2 applies to the existing conditions, as railways now receive their supply roughly in the ratio of 40 per cent. caking to 60 per cent. non-caking coals. At present, of the total supplies of Railway coal, grade II coals constitute about 25 per cent. roughly half of which comes from outlying fields and the balance from Bengal and Bihar. But as shown in alternative 2, the supplies of grade II coals should be brought down to 4 per cent. In the loco coal programme for the future, efforts should be made to eliminate, as far as transport will allow, coals whose calorific value is below a certain minimum, roughly. 11,500 Btu. per lb. **(i.e., useful heat** should not be less than 10,500 Btu. per lb.). Low grade coals can often be upgraded by washing to give superior performance in locomotives. **It is, however, important to mention that railway requirements shown in table 19 represent conditions for maximum economy. In actual practice, it may be necessary to accept lower grades of coal from nearer sources to avoid coal being hauled over long distances.**

This will save transport for higher grade traffic and may also reduce over-all fuel costs per unit of traffic produced (*i.e.*, rupees, annas and pies per thousand gross ton miles).

157. The implementation of the above plan will be thwarted unless the existing transport inadequacies are tackled immediately. It is generally not realised that lack of transport (wagon, power and track capacities) is hampering the flow of coal in the country. The transport problems are dealt with in Chapter XI.

TABLE 19

(AN ILLUSTRATION OF RAILWAY REQUIREMENTS ETC.........................)

(The figures are................)

Railways		Alternative 1			Alternative 2			Alternative 3			Alternative 4		
		100% caking			40% caking 60% non-caking			20% caking 80% non-caking			100% non-caking		
		Sel.	Gr. I	Gr. II	Sel.	Gr. I	Gr. II	Sel.	Gr. I	Gr. II	Sel.	Gr. I	Gr. II
Southern	Caking	46·4	44·0	9·6	18·6	17·6	3·8	9·3	8·8	1·9	..	..	..
	Non-caking	..	..	..	47·0	13·0	..	62·7	17·3	..	78·4	21·6	..
Central	Caking	38·9	51·0	10·1	15·6	20·4	4·0	7·8	10·2	2·0	..	..	..
	Non-caking	..	..	..	45·7	14·3	..	60·9	19·1	..	76·1	23·9	..
Western	Caking	44·7	43·7	11·6	17·9	17·5	4·6	8·9	8·8	2·3	..	..	..
	Non-caking	..	..	..	45·4	14·6	..	60·5	19·5	..	5·6	24·4	..
Northern	Caking	53·3	41·4	5·3	21·3	16·6	2·1	10·6	8·3	1·1	..		..
	Non-caking	..	..	..	50·3	9·7	..	67·1	12·9	..	83·9	16·1	..
Eastern	Caking	51·8	35·0	13·2	20·7	14·0	5·3	10·4	7·0	2·6	..	..	..
	Non-caking	..	..	..	44·7	15·3	..	60·9	19·1		76·1	23·9	..
North-Eastern	Caking	47·7	42·7	9·6	19·1	17·1	3·8	9·5	8·6	1·9	..	..	..
	Non-caking	..	..	..	46·5	13·5	..	62·0	18·0	..	77·5	22·5	..
TOTAL	Caking	48·0	41·8	10·2	19·2	16·7	4·1	9·6	8·4	2·0	..	..	..
	Non-caking	..	..	..	46·7	13·3	..	62·3	17·7	..	77·9	22·1	..

NOTE.—The quantities may have to be modified to reconcile with the Coal Board's decision regarding the future production of coking coal.

RECOMMENDATIONS

158. We Recommend that—

(i) Loco Coal requirements should be estimated on the basis of the suitability of each grade of caking or non-caking coal for different categories of locomotives as indicated in para. 146, adjustments being made for accepting inferior coals from nearer sources,

(ii) Efforts should be made to exclude from the future Loco Coal programmes, as far as transport permits, coals whose calorific value is below 11,500 Btu. lb., and

(iii) The use of low grade coals (calorific value below 11,500 Btu. lb.) on shunting locomotives should be gradually discontinued; districts or zones which receive supplies of coal over long leads should receive prior attention.

CHAPTER VIII

EXISTING CONDITIONS OF SUPPLY AND DISTRIBUTION OF LOCO COAL

ORGANIZATION

159. Prior to the year 1944 the practice of the Indian Railways was to call for tenders from collieries and then to select coals for their individual railway requirements. The Coal Commissioner's Organisation came into existence with the promulgation of the Colliery Control Order in the year 1944, and took over the control of distribution of coal in the country. With this change, the distribution of coal to railways become the responsibility of the Coal Commissioner. The existing system introduced in 1948, allocates loco coal orders to different collieries on behalf of the railways in the following manner:—

> "Demands of the railways are broken up gradewise. Sixty per cent. of the raisings of each colliery is taken as 'steam'* coal. The availability of steam coal is then worked out field by field after deducting the orders for steel works, bunkers, export, etc. The gradewise demands of the railways are then correlated to the steam coal available in the different grades, and orders are placed with the collieries on the basis of the ratio of demand to steam coal availability."

*(NOTE.—Steam coal is coal larger than 1″ but generally not larger than 6″ or 8″ in size.)

160. The Chief Mining Engineer, Railway Board, (who manages Government collieries) has charge of the distribution of railway coal from all sources and the above system is followed by him under the control of the Coal Commissioner.

Supply Conditions

161. The answers received to our questionnaire dealing with the railway coal supplies are summarised in Appendix 11. They have brought out the following features:—

(i) An enormous increase has taken place in the number of collieries supplying coals to individual railways.

(ii) The railway requirements have been spread (some as small orders) over a large number of collieries in the different coal fields.

(iii) Great variations have existed in supplies as a result of sheds receiving coal from different collieries from month to month.

Number of Collieries

162. Table 20 shows the number of collieries which have supplied coal to three major railways in the years 1939-40, 1943-44, 1944-45 and 1950-51. The period from 1939 to 1951 can be divided into two spans, *viz.* 1939-1944 and 1945-1951.

Table 20

Railway	Total number of collieries that have supplied coal in the year.			
	1939-40 Span 1	1943-44	1944-45 Span 2	1950-51
E. I. R.	23	50	258	511
B. N. R.	12	49	60	113
G. I. P.	29	70	174	371

In the first span (1939-1944) there is a gradual increase in the number of collieries, which arose from increased demands, and from production difficulties experienced in the earlier period of the second world war. In the second span there is a marked increase in the number of collieries in the commencing year (1944-45), coinciding with the introduction of the Coal Commissioner's Organisation. The number continued to increase rapidly in the subsequent years with the result that in the year 1951 the East Indian Railway received coal from 511 collieries as against 23 in the year 1939-40, the B.N. Railway from 113 collieries as against 12 and the G.I.P. Railway from 371 as against 29. This marked increase in the number of collieries during the second span is attributable to—

(i) Coal Commissioner's system described above, and

(ii) shortage of wagons, locomotive power and ships.

163. Table 21 illustrates the loco coal programme issued by the Coal Commissioner for the period June to September 1951. A point to note from this table is that the actual number of collieries that have supplied coal to each railway from month to month was considerably greater (three to four times) than the number indicated in the programme. This shows that the loco coal programme framed by the Coal Commissioner for allocating loco coal orders to different collieries, fails to materialise in practice. This failure helps to swell enormously the number of collieries supplying coal to individual railways.

Ttble 21

Number of Collieries that have actually supplied coal to Railways against Loco Coal Programme from June to September 1951.

Railway	June	July	August	September	As per programme
E. P.	83	89	134	95	33
Assam	67	71	69	31	19
E. I.	195	189	226	151	132
G. I. P.	162	167	155	166	55
BB & CI—					
B. G.	162	156	234	196	68
M. G.	126	126	130	130	63
O. T.	91	149	95	153	47
B. N.	69	86	81	81	72

Small Orders on Collieries

164. Table 22 presents an analysis of the collieries that supplied coal to the G.I.P. Railway in the years 1943-44, 1949-50 and 1950-51. We find that only 2 collieries supplied coal to this Railway in 1943-44 in quantities of 50 tons or less but the number of such collieries increased to 79 in 1949-50, falling to 62 in 1951-52. The number of collieries that supplied coal in quantities ranging from 50 to 100 tons, was nil for 1943-44, 24 for 1949-50, and 39 for 1950-51. The number of collieries that supplied more than 1000 tons on a single order was only 63 in the year 1943-44, but it increased to 133 in 1950-51. This illustrates how the requirements of a single railway system have been split up into small orders and spread over a large number of collieries.

Table 22

Supply quantity on a single loco order	No. of collieries concerned with supplies to the G. I. P. Railway in the year		
	1943-44	1949-50	1950-51
50 tons or less	2	79	62
51 to 100 tons	Nil	24	39
101 to 500 tons	1	86	104
501 to 1000 tons	4	22	33
Over 1000 tons	63	124	133

VARIATIONS IN SUPPLIES

165. Table 23 shows that sheds with daily consumption not exceeding 25 tons have received coal from 3 to 34 collieries and that sheds with daily consumption in the range of 101 to 150 tons have received coal from 15 to 66 collieries. This state of affairs has been brought about by change of supplying collieries from month to month. The number of collieries supplying coal to individual sheds must be kept down to a minimum in order to avoid stacking difficulties, to minimise mixing and combustion problems, and to ensure control of quality.

TABLE 23

Railway	Shed group		Maximum No. of collieries that have supplied coal to a single shed in the shed group during the year 1950-51.
	Average Consumption	No. of sheds.	
E. P.	Upto 25 tons	6	27
	101 to 150 tons	3	66
	201 to 250 tons	1	26
Central	Upto 25 tons	10	34
	101 to 150 tons	7	42
	201 to 250 tons	2	39
B. N.	Upto 25 tons	3	3
	101 to 150 tons	3	15
	201 to 250 tons	4	27

166. The variations in supplies have also resulted in proportions of the various grades of coals in ground stocks at sheds being different from actual requirements. Apart from this, the shedwise distribution of coal has been uneven, resulting in very low stocks at several sheds in spite of the overall stock position of the railway concerned being satisfactory. Under the present system the controlling authority is not informed of the stock position of different grades of coal in individual sheds.

CAUSES OF FAILURE TO KEEP TO SUPPLY PROGRAMME

167. We are told that the difficulties experienced in keeping to the loco coal programmes arise from the following causes:—

(i) Although, as a rule, there is shortage of wagons, there are frequent occasions (in day-to-day working) on which there is wagon surplus. In order to avoid accumulation of empties, the surplus wagons are sometimes supplied to collieries for loading railway coal, even though these collieries may not be on the loco coal programme for the particular railways.

(ii) Collieries sometimes fail to meet commitments on account of production difficulties.

(iii) Some collieries give preference to industrial orders when wagon supply position is satisfactory.

(iv) Indents for wagons placed by collieries do not materialise on account of shortage of wagons.

(v) Re-allocations and diversions of coal are made by the Coal Commissioner's Organisation to meet emergency demands.

(vi) Allotment of loco coal orders to several collieries is often made to the extent of 100 per cent. (sometimes more) of their steam coal production. This leads to loading of slack with the large steam coal.

(vii) Occasionally allotments of wagons are made in excess of the capacities of the routes and junctions. These capacities vary, and timely information about such variations is not always available with the allotting authorities.

SUPPLY PROBLEM

168. The difficulties which the railways have experienced in maintaining high standards of performance and affecting economy in the consumption of coal in locomotives, on account of the present supply conditions are summed up as follows:—

(i) With a large number of collieries on loco coal orders for each railway, the inspection on the part of the Coal Commissioner's Organisation has become ineffective; some railways have reported that about a third of their supplies contain excessive (20 to 40 per cent.) slack and dust and shaly matter. It is clear that individual collieries are failing to supply according to grades specified. The railways are unable to report on all cases of defective supplies as their limited fuel control organisations are not able to cope with quantities of coal received from numerous collieries. Penalties imposed by the Coal Commissioner on the collieries against whom complaints have been established, have often proved ineffective in the past and the railways have been compelled generally to divert such inferior coals to uses in unimportant services.

(ii) Coal supplies of the same grade drawn from widely varying sources of caking and non-caking varieties have often to be stacked together on account of shortage of stacking space in sheds. The result is that unknown mixtures of coal are burnt in locomotives day-to-day, and the engine crew are unable to achieve proper control over firing conditions. Moreover under such conditions of mixing it is not possible for the railways to make specific complaints about the nature or behaviour of one or other of the coals.

(iii) Drafting and the air supply of locomotives cannot be set to give the best results with coals of widely varying sizes (practically run-of-mine), nor with mixtures of caking and non-caking varieties.

(iv) Bulk densities (cubic feet per ton) of coals in the same grade as supplied to any one shed differ, the values ranging from 38 to 44 cubic feet per ton depending upon the source of supply. This has made it difficult for railways to base issues of coal to locomotives on the calibration of the locomotive tender and/or on the capacity measures of the basket and bucket loads, etc. Thus, railways are unable to determine reasonably accurate trip rations for the locomotives in different services and cannot exercise efficient control over fuel consumption.

(v) At present, coal-loads move from widely spread collieries in the coalfields to numerous consuming points on a railway and owing to failures of supplies of wagons, diversions of coal-loads have been a common feature. This has made it difficult for railways to obtain effective checks on receipts as against despatches, and to plan shedwise allotment by which they keep to the minimum the number of collieries supplying coals to a single shed.

169. Under the present practice the requirements of individual railways are widely spread over the coalfields. This has led to—

(i) a complicated system of maintaining checks on loadings and despatches,

(ii) failures of collieries to meet commitments,

(iii) irregularities on the part of the collieries in placing indents for wagons,

(iv) difficulties on the part of allotting authorities in making re-allotments which are sometimes necessary, and

(v) considerable marshalling and wagon detentions, both in the colliery base stations and enroute etc. which to some extent account for shortage of wagons.

170. We are of the opinion that even an attempt to raise the qualifying output of the collieries to such a figure as will reduce the number of collieries on the loco coal programme to about 100 will not bring success to the present system. In fact the loco coal programme for the period January to June 1952 which the Coal Commissioner had based on a qualifying output of the colliery of 1000 tons or more a month did not achieve the desired results. It neither brought a reduction in the total number of collieries supplying coal to a railway nor produced any measure of rationalisation in respect of supply sources to enable bulk supplies being moved from fixed (allocated) sources. Checks on coal loadings at the collieries also proved ineffective owing to inadequacy of inspection staff.

171. A solution of the supply problem lies in the abandonment of the present practice of programming loco coal orders. A new plan or scheme is needed which will minimise and fix the sources of supply for each railway on a long term basis, and which will eliminate the need for day-to-day adjustments of coal allotments. The wagon and power supply are insufficient to meet the needs of the present day highly increased traffic and expanded demands of the country. We deal with the transport question in Chapter XI.

172. We recommend that action be taken to organise loco coal supplies so that the following conditions are satisfied:—

RECOMMENDATIONS

(i) Quality. efficient control is exercised on the quality of coal so that supplies made to Railways are in accordance with specifications.

(ii) Supply and grouping. districts or zones of a Railway are supplied coals from fixed sources, a source being either a group of collieries or a single colliery. The collieries selected to form a group should be on the same 'Pilot'. They should be chosen so that the mixing of their coals may be done without causing combustion troubles. The quantities drawn from each group towards Railway supplies should be guaranteed in advance.

(iii) Distribution and grouping. As far as practicable coal for any consuming point on a Railway is obtained from the nearest group source. The group and the connected base station are such as will permit the movement of coal to districts or zones without entailing much marshalling at base stations (and enroute) and without involving cross movements.

CHAPTER IX

PROPOSED PLAN FOR SUPPLY AND DISTRIBUTION OF COAL

QUALITY AND CONTRACT

CONTROL OF QUALITY

173. The Committee attaches great importance to quality of the coal supplied to railways. The Coal Commissioner has given us details of his existing organisation for testing and inspecting coal samples taken from the seams, from the raisings, and direct from the wagons as they are being loaded at the collieries. He has also explained the procedure for maintaining checks on wagon loadings at colliery pitheads etc. His inspecting staff is expected to keep continually under observation the quality and quantity of coal produced by the collieries (widely spread over the different coal-fields) to ensure satisfactory quality in the grades of coals raised and supplied to Railways, other Government concerns and for export. **We feel that the present organisation is inadequate for the task and should be strengthened. This measure, however, will not in itself be a solution of the problem. The Committee considers that a complete change should be introduced in the supply system and that the responsibility in regard to quality should primarily rest upon the collieries themselves.** In other words, the collieries **should test daily their own coals as loaded. Quality will improve if supplies are made under suitable contract conditions. Railways have expressed themselves in favour of reversion to the system of inviting tenders i.e., the system in vogue before 1944.**

174. The Coal Commissioner's views on this matter are reproduced below:—

> "It is felt that even under the existing Colliery Control Order, offers for supply of coal to railways can be invited in future from collieries. When these offers are received, contracts for the quantity and quality as per grade specification may be drawn up between the collieries approved and the railways. This will not only ensure satisfactory supply of coal in quantity, but will also bind the collieries to supply coal to correct and agreed upon specification in grade and size. In the contract, penalty clauses can be incorporated, which will help to maintain standards. It is, however, to be definitely stated that the best plan would be for the railways to select their coals in consultation with the Chief Mining Engineer, Railway Board, as they used to do in the past. This system worked very satisfactorily and is strongly recommended. The Chief Mining Engineer should call tenders for coal supply to railways".

Contract Basis

175. In the light of the above remarks we consider that railways should in future select their coals by inviting offers from collieries and arranging for their supplies on contract basis. The control of quality is inherent in this arrangement, as the conditions of contract can be made stringent enough to prevent supply of grades lower than those contracted for.

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176. The contract basis, however, brings in other problems which arise out of changed conditions of supply, demand and transport. Industrial consumers and railways now require about 30 per cent. more coal than they did in pre-war days, **but transport improvements** have not kept pace with these demands. The line and junction capacities on certain railway systems are now practically fully utilised, and the bottlenecks have shown up more obviously on account of increased traffic all round. Wagon requirements for the import of food grains and for the increased export of coal and iron ore in recent years have also contributed materially to the present difficulties of coal transport. It will take some years before satisfactory conditions are reached.

177. We feel therefore that individual railways cannot for some years be given full choice in selecting collieries from the acceptable offers, as the choice of more than one railway might fall on collieries confined to one field or on collieries widely spread over different fields. The allocation of the collieries, whose offers are approved for supply of coal to railways, will have to be made 'in consultation' to avoid production and transport difficulties.

178. **To meet the situation we consider it necessary to set up a standing Loco Coal Committee consisting of representatives of Railways, the Railway Board, and the Coal Commissioner's Organisation.** The Chairman of the Railway Board or his nominee may act as Chairman, and the Chief Mining Engineer (Railway Board) as Member-Secretary of the Committee. The Chief Mining Engineer should invite offers from collieries and submit them to the Committee for scrutiny and acceptance. Allocations of the approved offers for coal supply may then be worked out by the Committee according to supplies and transport available. The Committee should meet periodically, say once in three months, to review the supply position and once a year to scrutinise and approve offers from collieries, and to frame annual loco coal programme.

SUPPLY AND GROUPING

Grouping of Collieries

179. The great increase in the number of supplying collieries during the last decade and the disadvantages of the resultant supply conditions discussed in paras 168 and 169, Chapter VIII, point to the desirability of grouping collieries. The object of grouping collieries is to ensure consistency in quality and regularity in respect of supplies made to **districts or zones** of a railway.

180. **Supply Sources.**—There are approximately 810 collieries in the Bengal and Bihar coalfields and 41 in the outlying fields. At present no less than 500 collieries take part in meeting loco coal requirements. Many of these collieries produce less than 1500 tons of coal per month, *i.e.* less than 1000 tons per month of loco 'steam coal'. The requirements of a single district or zone of a railway (for any one grade of coal) range from roughly 2,000 to 8,000 tons per month. These requirements cannot be met from a single colliery having a small output. Table 24 below shows the number of collieries (gradewise), connected with each base station in the Bengal and Bihar coalfields.

181. **On a rational basis, the supply of coal to a consuming point should be made as far as practicable from a single base station, so that coal may move in block loads of one quarter to full rake, depending upon the demands of the consuming point.** In order to achieve this, it is necessary to ensure that the collieries on which orders are placed are able to supply the quantities required regularly from day to day. Collieries with large output can generally meet this condition, but such collieries are limited in number and are normally called upon to meet high priority demands in respect of bunker and export coal, and coal for the steel industry.

TABLE 24

COLLIERIES CONNECTED WITH BASE STATIONS IN BENGAL AND BIHAR FIELDS PRODUCING SELECTED 'A' GRADE TO GRADE II COAL AS IN 1950-51

Coalfield	Base station	No. of collieries (gradewise) Sel. A	Sel. B	Grade I	Grade II	Total
Raniganj	Ondal	12	76	61	8	157
	Asansol	5	9	4	...	18
	Sitarampur	11	5	12	21	49
	Barakar	6	7	7	29	49
	Radhanagar	5	3	...	...	8
	Chaurasi	4	2	...	...	6
		43	102	84	58	287
Jharia	Patherdih	3	21	11	46	81
	Kusunda	1	18	8	44	71
	Katrasgarh	...	6	9	41	56
	Bhojudih	7	10	1	4	22
	Bhaga	4	13	1	3	21
	Mohuda	3	11	6	24	44
		18	79	36	162	295
Bokaro and Karanpura	Gomoh	...	1	3	10	14
	Barkakana	...	7	12	9	28
		...	8	15	19	42
	Giridih	2	...	...	...	2
		2	...	...	...	2
Grand total coalfields.	Bengal and Bihar	63	189	135	239	626

182. **Grouping Scheme.**—We have developed a scheme of grouping collieries grade-wise and pilot-wise into 'group sources' of supply, each with an annual raising of 80,000 tons or more. This scheme is included in Appendix 12. Collieries in the outlying fields are ungraded and located widely apart. The grade-wise and pilot-wise grouping of these collieries has not therefore been attempted.

183. In order to provide a safe margin for seasonal and other fluctuations in output, **the scheme is based on the assumption that approximately one third of total raisings (i.e., 55 per cent. of the steam coal) of each group will be available for loco supplies.** The criterion for including collieries in a group (raising any one grade of coal) is their close proximity and this will usually permit mixing of coals in the group without causing combustion trouble.

184. An extract from the illustrative grouping scheme is given is in Table 25.

TABLE 25

ABSTRACT OF GROUPING SCHEME

Field	Number of collieries					Number of groups				
	Sel. A	Sel. B	Gr. I	Gr. II	Total	Sel. A	Sel. B	Gr. I	Gr. II	Total
Raniganj . . .	43	102	84	58	287	14	18	12	9	53
Jharia	18	79	36	162	295	10	20	11	17	58
Bokaro and Karanpura.	.	8	15	19	42	...	7	8	4	19
Giridih . . .	2	...	...	...	2	2	...	...	...	2
Total Bengal and Bihar fields.	63	189	135	239	626	26	45	31	30	132
Other fields . .	...	...	...	...	41	...	...	...	...	41
GRAND TOTAL .	...	...	...	...	667	...	...	...	...	173

185. It will be seen that 287 collieries of the Raniganj field have been reduced to 53 groups, 295 collieries of the Jharia field to 58 groups, and 42 collieries of the Bokaro and Karanpura fields to 19 groups. The total number of 626 collieries of the Bengal and Bihar coalfields have been placed under 132 groups. With 41 collieries of the outlying fields added to this number, the total number of 667 collieries have been formed into 173 group sources. The main advantage to be derived from grouping is that complete groups can be assigned to districts or zones of a railway system. This permits a long term basis for supply and distribution and eliminates the present difficulties arising from widely spread collieries supplying coal to numerous consuming points on a railway.

186. **The grouping scheme discussed above can be immediately introduced without affecting the present supply condition in other respects.** When railways, however, adopt the system of selecting their

example for working out a fresh grouping scheme for the collieries whose offers are accepted for supply of coal to railways.

Loco Coal Programme Based on the Grouping Scheme

187. A loco coal programme (Appendix 13a) has been worked out to illustrate the application of the grouping scheme to distribution of coal to railways. Table 26, below, affords a comparison between the proposed progamme and the one issued by the Coal Commissioner for the period July to December 1952. It will be seen that under the grouping scheme, the Central Railway receives coal from 6 groups of the Bengal and Bihar fields and 12 collieries of the outlying fields as against 68 collieries shown on the Coal Commissioner's programme. The Western Railway receives coal from 14 groups of the Bengal and Bihar fields and 2 collieries of the outlying fields as against 87 collieries on the Coal Commissioner's programme. For the Eastern Railway, the 'group sources' work out to 51 as against 189 collieries, for the Northern Railway 17 as against 178 collieries and for the North Eastern Railway 9 as against 54 collieries. Under the grouping scheme supplies will be made from 94 groups of the Bengal and Bihar collieries and 27 collieries of the outlying fields, against 541 collieries shown on the Coal Commissioner's programme for all the railways.

TABLE 26

A COMPARISON BETWEEN THE PROGRAMME BASED ON THE 'GROUPING SCHEME' AND THE ONE ISSUED BY THE COAL COMMISSIONER JULY TO DECEMBER, 1952.

Local Coal Programme Based on Grouping Scheme

	Railways						
	Southern	Central	Western	Northern	Eastern	North-Eastern	Total
Bengal & Bihar fields	4	6	14	17	44	9	94
*Other fields	6	12	2	...	7	...	27
TOTAL	10	18	16	17	51	9	121

July to December 1952—Coal Commissioner's Programme.

	Southern	Central	Western	Northern	Eastern	North-Eastern	Total
Bengal & Bihar fields	52	40	70	78	173	54	467
*Other fields	13	28	17	...	16	...	74
TOTAL	65	68	87	78	189	54	541

*Does not include Assam coalfields.

188. Although the total number of collieries supplying coal to railways may be large, **an important advantage of the proposed programme is that supplies for individual railways will be confined to limited areas of the coal fields and the traffic routes will be more or less permanently fixed in contrast to the supplies being spread over the entire coalfields under the existing programme. Another feature is that complete districts or zones of a railway will deal with caking or non-caking coals only. We therefore, consider that the 'grouping principle' should be immediately adopted for rationalising supply sources.**

DISTRIBUTION AND GROUPING

189. For a correct appreciation of the advantages of coal distribution under the grouping scheme, it is essential to state briefly, even at the risk of repetition, the defects in the present distribution arrangements. The present system is defective in the following respects:—

(i) It entails excessive marshalling and detentions of wagons at base stations and junction yards en route.

(ii) It involves numerous bookings from collieries to sheds, resulting in cases of misdirection and losses of wagons en-route.

(iii) It makes difficult a speedy checking of receipts against despatches.

(iv) It creates difficulties in respect of stacking and regulating of ground stocks at sheds.

(v) It furnishes more scope for theft and pilferage due to longer and more frequent "hold-up" of wagons en route.

(vi) It does not provide for effective weighment or quality checks on supplies at the various receiving points.

(vii) It necessitates larger ground stocks due to individual sheds being far removed from collieries.

Distribution Plan

190. The Committee considers that many of the above defects arise from numerous supply sources and receiving points, with consequent difficulties in transport, inspection and ground stocks, and we consider it essential to have a rationalised plan for distribution. **The main feature of such a plan should be the introduction of distributing centres to serve as primary receiving points in respect of supplies to districts or zones.** The distributing centres would be located to ensure easy distribution of coal to individual sheds.

191. The advantages of such a plan would be:—

(i) minimising of marshalling and detentions en route and reduction in ground stocks at sheds due to movement of block loads (quarter to full rake) from base stations to distributing centres,

(ii) putting complete districts or zones on either caking or non-caking coals in order to:—

(a) enable locomotives operating in each zone to be drafted accordingly,

(b) put trip rationing on a more reliable and accurate basis, and

(c) minimise diversions,

(iii) facilitating check weighment and quality test by centralising inspection of this work at the distributing centres.

(iv) simplifying investigation of complaints regarding defective supplies, and

(v) making it easier for Railway Headquarters to exercise control over supply and distribution of coal through the medium of distributing centres.

192. The Committee considers that it is possible to evolve a workable plan ensuring the above advantages. The basis of such a plan is given in Appendix 13a, which specifies supply sources (groups connected with base stations), traffic routes, distributing centres and district or zonal requirements of different grades of coal for all railways, and illustrates the feasibility of the scheme.

ILLUSTRATION

193. We take the case of the Western Railway to illustrate the detailed working of the distribution plan (Appendix 13b and 13c). According to our new plan this railway receives coal from two base stations in the Jharia coalfields, one base station in the Bokaro coalfields, and one base station in the CIC coalfields. There are eight districts (zones) of the Western Railway. The Jharia and Bokaro coalfields supply caking coals to six districts, and the CIC fields supply non-caking coals to the remaining two.

194. Under the plan Gangapur district (Broad Gauge) with a monthly consumption of 19,800 tons receives daily 12 wagons of Selected 'B' coal from one group, 17 wagons of grade I coal from two contiguous groups, and 4 wagons of grade II coal from one group, a total of 33 wagons from Kusunda base in the Jharia coalfield. This enables roughly two-thirds of a rake to move daily from Kusunda to Agra East Bank, which serves as a distributing centre for Gangapur district. Similarly, Ahmedabad district (Broad Gauge) with a monthly consumption of 23,400 tons receives daily 18 wagons of Selected 'B' coal from two contiguous groups, 4 wagons of grade II coal from one group, a total of 22 wagons a day from Kusunda base. It also receives 17 wagons of grade I coal from one group connected with Gomoh base. Thus two block loads of 22 and 17 wagons will move daily from Kusunda and Gomoh bases respectively to the district distributing centre, Ratlam. Supplies have been arranged for Bulsar District (Broad Gauge) in the shape of 15 wagons of Selected B and 3 wagons of grade II coal from Kusunda base in the Jharia field, and 12 wagons of Grade I coal from Gomoh base in the Bokaro field. The two block loads so formed will move daily *via* Cheoki and Bhusaval to the distributing centre Nandurbar. The four Metre Gauge districts (including Saurashtra) and one Narrow Gauge district (Pratapnagar) are provided with distributing centres at transhipment junctions namely Agra East Bank and Ratlam.

195. The requirements of Saurashtra Division (now Gondal Region) of the Western Railway have been completely met by rail route in the shape of 29 wagons of non-caking coal moving daily in a block load from Manendragarh base in the CIC fields to the distributing centre at Ratlam, for transhipment at Sabarmati and Viramgam. Supplies of Pratapnagar District (to the extent of five wagons a day) are also met from Manendragarh base and will move upto Ratlam with the daily block load for Saurashtra

196. The movement of block loads as described above will reduce marshalling and detentions with resultant shortening of turn-round period and economy in coal consumption in shunting work at base stations and enroute. It is expected that in the case of Western Railway, a saving of 1 day in the turn-round period will increase the overall transport availability by about 5 per cent. as shown by the calculation in Appendix 14. Similar illustrative plans for other railways are given in Appendix 13.

Labelling System

197. The labelling system illustrated in Appendix 15, will facilitate the handling of coal loads at junction points and distributing centres. Distinctive symbols—circle, triangle, square, etc.—will denote the consignee railway and serial numbers shown within the symbols will indicate the respective districts or zones of the consignee railway. For example, the Western Railway has been allotted a circle for its symbol and serial numbers 1 to 8 to indicate the 8 districts. The symbols will enable the staff to recognise the destinations of coal loads at a glance. Besides speeding up shunting operations, this will eliminate misdirection of wagons. The serial numbers within the Railway symbols will make it easier for the distributing centres to re-direct coal loads to respective districts or zones.

198. There is also a colour scheme. This seeks to provide a visual indication of the grade of coal loaded in the wagon by means of a strip of a distinctive colour marked on the side label such as red for Selected 'A', green for Selected 'B', yellow for grade I and blue for grade II coals. This will facilitate the distribution of different grades of coal to individual sheds through the distributing centres.

199. The standard side labels now used will be continued and the symbol and colour schemes will be the additional features of these labels to provide visual indications.

Inspection and Accounting

200. The Committee considers that at present it is not possible for railways to have effective inspection and weighment checks at individual receiving sheds. The existing arrangements are unsatisfactory in view of the importance of control of quality and quantity. The proposed distribution plan envisages centralisation of inspection and weighment checks at distributing centres. Under the plan the inspection and weighment checks on the Western Railway will now be carried out at the three distributing centres instead of 56 sheds. Similarly, linking of receipts with dispatches is facilitated when it is carried out at the distributing centres. The distributing centres will prepare returns of coal loads received and check them against the despatch invoices received from collieries. Regulation of further distribution to sheds will be an internal arrangement. This means that only the distributing centres will deal with the supplies coming from collieries, which will facilitate and expedite detection and adjustment of discrepancies. A system of identity cards for wagons and also sealed labelling of wagons is discussed in Chapter XIII.

Control by Headquarters

201. Under the proposed plan, the railway headquarters will have to deal mainly with the distributing centres in regard to all coal matters. The distributing centres will provide a medium for exercising better control all round and ensuring efficient and expeditious handling of coal matters.

Ground Stocks

202. The grouping of supply sources makes it possible for coals to be stacked grade-wise without causing combustion trouble. The sheds will now maintain separate stacks for four grades of coal, instead of separate stacks for each colliery and grade. The reduction in transit time due to block movements of loads and due to shortening of loads with distributing centres serving as 'pools', will make it possible to keep down the stocks at sheds. An illustration of this feature in the case of the Western Railways is worked out in Appendix 16. It will be seen that safe ground stocks in the case of Western Railway can be reduced from 30 days' consumption to 26 days' consumption, giving a reduction in the capital locked up in ground reserves to the extent of rupees 5·2 lakhs.

Financial Implications

203. The proposed distribution plan involves extra expenditure on coal organisation at the distributing centres. The Northern Railway has a distributing centre at Ghaziabad, which handles 100 wagons of coal per day and affords a case for illustrating the financial implication of the proposed plan At present, Ghaziabad handles only the distribution of coal and weighment checks on coal supplies. Appendix 17 shows that the actual working cost of the present Ghaziabad organisation comes to an average of 8½ pies per ton of coal handled. If we add an inspection unit to this organisation in accordance with the proposed plan, the cost per ton will come to an average of 12 pies per ton. Examples of smaller units handling from 20 to 40 wagons per day have also been worked out in Appendix 17. The working cost in the case of smaller units is estimated to be in the range of 14 to 18 pies per ton of coal handled. Some railways prefer to have inspection squads, but the cost will not be affected as these squads will replace inspection units. On this basis, the estimated annual expenditure on distribution-*cum*-inspection organisation for the three distributing centres (8 districts) of the Western Railway works out to an average of 12·7 pies per ton or total annual cost of about rupees 88,200.

204. The additional expenditure on distribution-*cum*-inspection organisations for all railways works out to rupees 7½ lakhs, which is roughly 0·25 per cent. of the annual railway fuel bill of 30½ crores We are of the opinion that this additional expenditure is more than justified in view of the benefits that will result from the proposed plan for supply and distribution of coal, *viz.*—

(i) efficient control of quality and quantity of supplies,

(ii) increased transport availability,

(iii) simplification of stacking conditions and reduced ground stocks, and

(iv) reduced scope for losses on account of pilferage and coal handling.

205. We recommend that—

RECOMMENDATIONS

(i) The Railways should in future select their own coals by inviting offers from collieries and by arranging for supplies on contract basis,

(ii) A standing Loco Coal Committee should be set up to undertake all work connected with the framing of Loco Coal programmes, scrutiny, acceptance and allocation of the approved offers according to the supplies and transport available. The Committee should consist of representatives of Railways, the Ministry of Railways and the Coal Commissioner. The Chairman of the Railway Board or his nominee may act as Chairman and the Chief Mining Engineer, Railway Board, as Member Secretary of the Standing Loco Coal Committee, and

(iii) In order to simplify and rationalise transport and to ensure regular and reliable supplies of coal to Railways, steps should be taken to introduce the system of grouping collieries, with distributing centres to serve as primary receiving points in respect of supplies to Railway Zones. A sample distribution Plan is given in Appendix 13.

CHAPTER X

PLAN FOR SUPPLY OF COAL TO THE SOUTH

COAL PROBLEM IN THE SOUTH

Lignite Potentialities

206. The Government of Madras have been exploring possibilities of working the South Arcot lignite for the last four years. The work so far carried out suggests that the lignite may be developed by open-cut quarrying. The over-burden (of earth and rock) averages about 180 ft. and the thickness of lignite seam averages 60 or 70 ft.; this gives a ratio of 3 : 1 for the over-burden (thickness) to the thickness of seam. Potentialities of this coal in South India are discussed in detail in Chapter VI.

207. Open-cut mining methods (for Black Coal) have been successfully employed in East Bokaro coalfields of Bihar, but an additional and serious problem with the South Arcot lignite is the control of large quantity of water, above and below the lignite seam. The development of irrigation projects is also linked up with the exploration and excavation work. Experiments are in hand to investigate the possibilities of the use of the South Arcot lignite directly in Thermal Power Stations, which may be connected with the Electric Grid System planned for the South. The possibilities of briquetting lignite for use as fuel for domestic and industrial purposes, and of carbonisation and other methods of treatment are also under examination. **It is hoped that, with the development of lignite, the South will in due course get partial relief in the matter of its fuel supply. For some years, however, it will continue to depend entirely upon supplies from the Bengal and Bihar and the outlying coalfields.**

Present Position

208. Table 27 indicates the coal demand and supply position in the year 1951-52.

COAL DEMAND AND SUPPLY OF SOUTH 1951-52

Consumers	Demands (Tons per month)	Actual Supplies (Tons per month)			Short Supply (Tons per month)
		Rail route	Rail-*cum*-sea route	Total	
Southern Railway	1,20,000	60,000	60,000	1,20,000	Nil.
Industries & Public	1,55,000	66,000	12,000	78,000	77,000
Total	2,75,000	1,26,000	72,000	1,98,000	77,000

209. The demands shown in the above table represent the bare requirements of the South. On the other hand the coal supplies to industry and the public have actually fallen short of the demands by 77,000 tons per month. In fact, the minimum railway requirements have been met at the cost of industry and public by frequently diverting non-railway supplies to meet railway demands.

210. The position regarding ground stocks on the Southern Railway has also not been satisfactory. In view of the distance of the South from the main source of coal supplies (Bengal and Bihar), the safe ground stocks on the Southern Railway should be of the order of 50 days' consumption. Against this the stocks have continued to remain at the low level of 7 to 12 days consumption or less. This critical stock position did not improve in spite of the fact that much coal was available in ground stocks of the Singareni Colliery pit-heads, which are the nearest points of supply to the South. This state of affairs is due to transport difficulties arising out of—

(i) inadequate line capacity and junction limitations of the rail routes,

(ii) high freight charges in respect of sea-borne supplies, and

(iii) unsteady and often inadequate shipping.

SHORT TERM PLAN

211. The Committee considers that a short term 5 year plan for the South should be adopted. Under this plan:—

(i) coal supplies should be increased to certain prescribed target figures so as to establish satisfactory supply and stock conditions in the South,

(ii) further increases in supplies to the South should be met from the outlying (Hyderabad) fields, as far as practicable,

(iii) the present receiving points on the Southern Railway should be converted into distributing centres and/or transhipment dumps to permit the movement of coal in block loads upto the receiving points,

(iv) complete railway districts or zones should be given supplies from fixed supply source, and

(v) the possibilities and economics of sea-borne supplies of coal to the South should be investigated; some colliers (coal carrying vessels) may be owned by the Railway.

The implementation of the short term plan will involve the immediate development of (1) the local and outlying coal resources and (2) the capacities of rail routes.

212. **Target for supplies.**—We suggest the following targets should be attained under the 5 year plan:—

(a) Southern Railway coal supplies should be stepped up from 1,20,000 to 1,35,000 tons per month.

(b) Public (non-railway) supplies should be stepped up from 78,000 to 1,65,000 tons per month.

The targets have been purposely kept low in view of the growing electrification of the South.

213. **Sea-borne supplies.**—The sea-borne supplies to the South, upto August 1951, were approximately 72,000 tons per month, out of the total monthly supplies of 1,98,000 tons. In the subsequent months, the sea-borne supplies fell to the level of about 40,000 to 50,000 tons (about 6 to 8 ship-loads) a month. When the target supplies are achieved, the total supplies of coal to the South will be of the order of 3,00,000 tons per month. The question arises what will then be the sea-borne part of the target supplies. In spite of the recent increase in the railway freight rates for coal, **it is more economical to move coal to the South by rail than by sea and if possible all coal would be best sent by rail.** This ideal, however, cannot be achieved for some years, and in the meantime sea-borne supplies will be required to supplement the rail supplies. The extent of the sea-borne supplies is restricted by:—

(i) the availability of shipping space for coal movement by sea,

(ii) unattractive sea freight and lack of proper colliers (coal carrying vessels), and

(iii) to a limited extent the loading and discharging capacity of Calcutta docks and Southern Ports.

214. The five Southern Ports (Madras, Cuddalore, Tuticorin, Cochin and Marmugao) have together a discharging capacity for 20 ship-loads of coal a month. This could be much increased if the unloading arrangements at the ports were improved, especially at Madras Docks (*see* Appendix 18, paras. 4 to 9). The coal loading capacity of the Calcutta Docks for coastal traffic (with four loading berths for coastal colliers). is about 24 ship-loads a month. However, the availability of shipping for this coastal traffic has in the past varied from 6 to 12 ships a month, and is now (1953) about 20 ships a month. The availability at Calcutta of shipping for coastal coal traffic has been increased only recently (since 1952). The Railways may consider the desirability of owning their own colliers.

215. We are of the opinion that, keeping all these factors in view, 12 ship-loads (72,000 tons) of coal per month is a workable minimum for sea-borne coal supplies for the next 5 years. These sea-borne supplies will be drawn from the Bengal and Bihar coalfields. **Hence we have to plan the movement by rail of the balance of 2,28,000 tons per month, which is nearly double the quantity of coal now moved by rail to the South.**

216. **Rail-borne supplies.**—In 1951-52 the sources, quantities, and receiving points (points of intake) for the rail-borne supplies are as shown in **Table 28.**

TABLE 28

RAIL-BORNE SUPPLIES TO THE SOUTH (PER MONTH) FOR RAILWAYS AND INDUSTRIES (1951-52)

Receiving points (points of intake)	Supply Sources	Quantities received	
		Tons per month	Wagons per day
1. Waltair	(a) Bengal & Bihar	33,000	55
	(b) Talcher	12,000	20
	TOTAL	45,000	75
2. Bezwada	(a) CP/CIC	10,200	17
	(b) Singareni	40,800	68
	TOTAL	51,000	85
3. Dronachelam (*via* Secunderabad).	Singareni	9,000	15
4. Raichur	CP/CIC	21,000	35
	TOTAL	1,26,000	210

217. Table I of Appendix 18 gives in detail the proportions of railway and public supplies received in normal times at different points of intake and the proposed increases therein under the five year plan. The increase in the intake capacity of Waltair in the course of the five years period, is from 75 to 105 coal wagons per day. This increase of 30 wagons will carry the increased output expected from the Talcher coalfields. On the Southern Railway there are no convenient points of intake other than Waltair for Bengal and Bihar rail-borne coal. **Under the 5 year plan Waltair will not therefore receive any additional rail-borne supplies from the Bengal and Bihar Coalfields.** It is accordingly necessary to concentrate on the development of the outlying fields if we are to achieve the target of rail-borne supplies for the South.

218. **Outlying fields.**—There are three outlying coalfields that offer promise of considerable increase in output, *viz.* Talcher, Singareni and CIC fields. The additional quantities that can be drawn in the near future from the three fields are as follows:—

Singareni	20,000	tons per month
Talcher	6,000	tons per month
CIC	30,000	tons per month
TOTAL	56,000	tons per month

219. **The intake points.**—Ghorpuri, Hotgi and Raichur—will not be able to handle even a part of the 30,000 tons of additional quantity per month (about 50 wagons a day) which the CIC coalfields can immediately offer. **Further development of output will therefore have to be confined to the Singareni and Talcher coalfields, which we are informed, can increase their output within 5 years by 80,000 and 20,000 tons per month respectively.** This will give a total ultimate increase of 1,00,000 tons per month which is the additional quantity required for building up rail-borne supplies to the target of 2,28,000 tons a month. **It is thus clear that the Government should extend and develop their Talcher collieries so that the target supplies for the South may be achieved (see Chapter III). The transport problems involved should be taken in hand forthwith.**

220. The development of the Singareni coalfields, which will eventually offer an additional output of 80,000 tons a month, will naturally influence the programme for developing the intake capacities of the receiving points. A five year project, involving an expenditure of about Rs. 4 crores, has been started by the Singareni coalfields to step up the output from 1,00,000 to 1,80,000 tons per month, and rupees one crore has been already spent on the purchase of new power plant and mining equipment for this project. **Subject to grant of additional funds** the project will be completed in five years as follows:—

	Aggregate output per month	Increment in output per month
	Tons	Tons
Immediately with transport made available.	1,20,000	20,000
December 1953	1,28,000	8,000
December 1954	1,36,000	8,000
December 1955	1,56,000	20,000
December 1956	1,80,000	24,000

221. The Committee envisages increase in the intake capacity of the five receiving points, Waltair, Bezwada, Dronachellam, Raichur and Hotgi by the following methods:—

(i) Extension of loops and sidings, building of additional crossing stations and remodelling of yards, also where necessary doubling of track.

(ii) Creation of dumps and extension of transhipment capacities at break-of-gauge junctions.

(iii) Provision of additional locomotives and/or replacement of older types.

(iv) Provision of additional wagons.

222. In line with Singareni development programme, the increase in intake capacity of individual receiving points will be effected as follows:—

(i) **Waltair-Bezwada.**—Extension of loops and sidings to accommodate 80 wagon train loads, remodelling of important junction yards (particularly Bezwada and Rajahmundry) and provision of additional crossing stations will enable the intake at Bezwada to be increased by about 120 wagons a day out of which about 80 wagons could be allotted for carrying public and loco coal (40 for loco and 40 for public coal) and 40 wagons for carrying general goods. The distribution of the 80 coal wagons can be 30 for Waltair and 50 for Bezwada. The creation of a public dump with necessary siding facilities along the Kistna Canal Bank at Bezwada will enable 14,000 to 16,000 tons of coal per month (about 23 wagons a day) to be carried into the interior for public supply by river transport. Extension of the transhipment dump at Tadepalli will increase railway supply *via* Bezwada—Tadepalli, route, by about 15 wagons a day.

(ii) **Dronachellam.**—Extension of transhipment facilities at Secunderabad, and also extension of transhipment dump at Manmad, will increase the intake at Dronachellam from 15 to 30(BG) wagons a day.

(iii) **Raichur.**—Provision of 12 to 15 XD locomotives in replacement of the existing 'M' class locomotives and provision of transhipment facilities and dump at Guntakal will increase the intake of coal at Raichur from 35 to 70 wagons a day.

(iv) **Hotgi.**—Extension of transhipment facilities and provision of additional locomotives (preferably YL class) will increase the intake at Hotgi to 10 wagons per day for meeting part requirements of Hubli District.

223. As a long term measure to meet the transport problem of the Southern Railway, it is necessary to double the track from Bezwada to Gudur and to convert the Metre-Gauge to Board Gauge from Gudur to Renigunta, or alternatively to double the whole section from Bezwada to Madras. **Even the development of South Arcot lignite in the course of the next ten years, to yield a production of 1.2 million tons per annum, will meet only one-third of the total fuel requirements of the South.** The lignite produced will be mainly absorbed in areas surrounding the lignite mines and will thus replace the sea-borne supplies received *via* Cuddalore and Tuticorin ports. The need for:—

(a) moving by rail the remaining two-thirds of coal requirements of the South, and

(b) meeting the additional demands for transport resulting from the industrial development of the South,

warrants energetic pursuance of the plans for increasing the line capacities and transport facilities over the main rail routes in the South **particularly by doubling the Bezwada-Madras section.**

TABLE 29

Phase to phase Rail Borne and Sea Borne Supplies under the Supply plan for the South.

Supplies **Target**

Railway 1,35,000 tont per month.
Public 1,65,000 tons per month.
TOTAL 3,00,000 tons per month.

Development Programme	Southern Railway								Industries							
	By Rail			By Sea					By Rail			By Sea				
	Tons per month	Wagons per day	Percentage of target	Tons per month	Ship loads per month	Percentage of target	Total tons	Percentage	Tons per month	Wagons per day	Percentage of target	Tons per month	Ship loads per month	Percentage of target	Total tons per month	Percentage of target
Existing Supplies	60000 *(81000)	100	44·5 (60·0)	60000 (39000)	10	44·5 (29·0)	120000 (120000)	89·0	66000 (68000)	110	40·2 (41·2)	12000 (11000)	2	7·3 (6·7)	78000 (79000)	47·3 (47·9)
1st *Phase* to be completed by December, 1953.	75000	125	55·5	48000	8	35·5	123000	91·0	70000	117	42·4	24000	4	14·6	94000	57·0
2nd *Phase* to be completed by December, 1954.	81000	135	59·9	42000	7	31·1	123000	91·0	78000	130	47·2	30000	5	18·2	108000	65·4
3rd *Phase* to be completed by December, 1955.	85000	142	63·3	42000	7	31·1	127000	94·1	89000	148	53·9	30000	5	18·2	119000	72·1
4th *Phase* to be completed by December, 1956.	87000	145	64·5	42000	7	31·1	129000	95·6	111000	185	67·3	30000	5	18·2	141000	85·5
5th *Phase* to be completed by December, 1957.	99000	165	73·3	36000	6	26·7	135000	100·0	128000	213	77·6	36000	6	21·9	164000	99·5

*The figures in brackets represent the supplies made during September '51 o February '52. The increase in the rail borne supplies is made at the cost of general goods traffic, and this cannot continue. Shipping has to be increased to supplement supplies by sea.

NOTE.—The plan reiterates that Rail-borne coal for the public will be increased from 40·0% to 77·6% of the target supplies at the end of 5 years. A schedule of 12 ships a month is to be maintained throughout the 5 year period.

224. Table 29 gives phase to phase development of the intake capacity of the receiving points and distribution of sea and rail-borne supplies. The total increase in capacity of the receiving points in the course of five years works out to 168 wagons per day including the 23 wagons for the public dump to be set up in the Kistna Canal Bank at Bezwada. This will raise (a) the total quantity of coal moved by rail from 1,26,000 tons to 2,27,000 tons per month against the target supply of 2,28,000 tons per month and (b) the ratio of rail-borne to sea-borne supplies both for Railways and public, from 2 : 1 to 3 : 1.

225. **Distribution to Districts or Zones.**—In five years under this plan, complete railway districts or zones will receive supplies from fixed sources. For instance with the completion of the first phase by December 1953, the whole of the Hubli District will receive supplies from CP/CIC coalfields and the Guntakal and Mysore Districts from Singareni coalfields, with the completion of the second phase by December 1954 whole of the Bezwada District will receive supplies from Talcher coalfields. With the completion of the fifth phase by December 1957, the Rayapuram and the Podanur Districts will use only Singareni coal. Only the Villupuram and Madura Districts, which are in the extreme South, will continue **to receive sea-borne supplies from Bengal and Bihar coalfields till the local resources of lignite are developed to supplement supplies.**

Additional Wagon Requirements

226. The increase in rail-borne supplies for the South involves additional wagon requirements. These have been worked out in Table 30.

TABLE 30

	Additional wagon requirments		Progressive Total	
	B. G.	M.G.	B.G.	M.G.
Phase I (to be completed by December 1953 or earlier)	250	60	250	60
Phase II by December '54 or earlier)	100	...	350	60
Phase III (by December '55 or earlier)	250	60	600	120
Phase IV (by December '56 or earlier)	200	80	800	200
Phase V (by December '57 or earlier)	400	100	1,200	300

Additional Expenditure

227. The Committee has examined the financial implications of the three methods of increasing the intake capacity of the six receiving points of the Southern Railways *viz.*,—

(i) extension of loops, sidings and remodelling of junction yards, and provision of additional crossing stations.

(ii) provision of additional loco power, and

(iii) creation of dumps/provision of transhipment facilities.

We are informed that the Southern and Central Railways have already examined the necessity of carrying out the improvements mentioned in (i) and (ii) above in order to meet increasing traffic demands and that the Southern and Central Railways are taking steps to make the necessary budget provisions for the purpose. In fact, the work in connection with the extending of the loops and sidings on the Bezwada-Madras section is already in progress. It will be seen that the execution of the proposed plan for the South will not involve, in the strictest sense, any new expenditure but indeed furnishes an additional justification for expediting the execution of the improvements already in hand. As regards new dumps and transhipment facilities, these are understood to involve only small extra expenditure to extend the facilities which already exist.

Anticipated Savings

228. Tables III and IV of Appendix 18 give calculations in regard to anticipated reduction in the cost of coal, taking into consideration the saving in freight charges (now operating costs) due to transfer of supplies from sea route to rail-route and loss in revenue on account of additional wagons to be employed on increased supplies by rail.

229. At the end of the first phase of the plan (*i.e.*, by December 1953) sea-borne supplies to the extent of 3 ship-loads per month (the entire supply for the Hubli District) will be completely replaced by rail-borne supplies. One ship load per month has, however, been added to the supplies received *via.* Madras Port in order to make up for the rail-borne coal of CP/CIC fields transferred from Rayapuram District to Hubli District. This will result in a net reduction of the railway fuel bill of the order of 26·4 lakhs per year. Again at the end of the fifth phase of the plan (*i.e.*, by December 1957), sea-borne supplies will be reduced by two ship loads a month *i.e.* from 8 to 6, resulting in a net reduction in the fuel bill of the order of rupee 6·8 lakhs per year. Thus the total net reduction in the cost of coal under the Southern Railway Supply Plan will be rupees 33·2 lakhs per year.

230. **We consider that the proposed plan is workable and that it will relieve fuel shortage in the South. The first phase of the plan involves the extension of transhipment facilities or of dumps, and the provision of additional 250 Broad Gauge and 60 Metre Gauge wagons along with necessary locomotive power and rail-route facilities for carrying increased quantities of both loco and public coal. The net annual reduction of about rupees 26½ lakhs in the cost of coal justifies action being taken immediately to implement the first phase of the plan.** As an immediate measure attention should be given to the full loading of the wagons (including the two ton overload allowance) especially when dealing with the Singareni coal and coal supplies to the South, where it would appear that there is the greatest need of this measure and where the maximum advantage will accrue—and immediately.

231. We recommend that—

RECOMMENDATIONS

(i) Wagons should be loaded to maximum permissible degree,

(ii) To meet the fuel requirements of the South, the Government should give high priority to the development of Talcher, Singareni and CP/CIC coalfields, and

(iii) The Ministry of Railways should immediately undertake development of the junction yards and line capacities along the rail routes from the above mentioned outlaying fields to the South.

CHAPTER XI

TRANSPORT DEFICIENCIES

Review

232. The Committee has observed lack of co-ordination in the planning of industrial and transport development. Consequently rail transport has lagged behind the country's requirements. There are several places where industries have been set up regardless of the availability of transport both for the supply of raw materials and for the disposal of finished goods. Planning for development of transport must indeed be done in advance if industrial development is not to be handicapped and throttled. It is essential to develop and plan transport so that there is economy in the wagon usage and that basic materials (such as coal etc.,) are supplied to industries at as low a cost as possible, thereby reducing the cost of production of finished goods. We will, however, restrict ourselves to detailed examination of the coal transport problem.

Coal and Transport Requirements

233. As stated in para. 33, Chapter III, the 1951 demand, production and supply of coal, were approximately 34½, 33½ and 30½ million tons per annum respectively. This means that transport has fallen short of both demand and production. The demand is expected to increase progressively to 52 million tons in the course of the next 10 years. To meet the increase, we have already made recommendations in Chapter III for zonal development of coal production in the country. The immediate problem is to meet the existing demand of 34½ million tons per annum which includes about 2 million tons for consumption at collieries. The total number of wagons required for loading at collieries to meet the immediate demand is about 4150 per day. The wagons actually supplied to Bengal and Bihar coal fields average about 3100 per day and those supplied to the outlying fields average 650 per day, a total of 3750. **This means that coal transport alone requires immediately some additional 400 wagons per day to meet fully the requirements of all consumers of coal in the country.** Assuming that the average turn-round period is 11 days (for all coal-fields) and that 10 per cent. of wagons in service are generally held over in sick lines and shops for repairs, the number of wagons now utilised for coal transport alone works out to about 45,000, whereas the number actually required is 50,000. There is thus a deficiency of about 5,000 wagons, or about 11 per cent. of the number now utilised in coal transport.

234. This overall deficiency of 11 per cent. is mainly due to:—

(a) uneconomic utilisation of available transport, and

(b) shortage of wagons and power and limitations of line capacity.

The uneconomic utilisation of available transport can be overcome by adoption of such measures as will:—

(a) enable coal to move in block-loads of quarter to full rakes over the longer portions of journeys from colliery base stations to destinations, and

(b) ensure full use of permissible "over-load allowance" of 2 tons above the marked carrying capacity of wagons.

SHORT TERM PLAN

Wagon Availability

235. In Chapter VIII we have examined the existing conditions of supply and distribution of loco coal, and we have recommended a plan for rationalising supply sources and for district-wise allocation of loco coal supplies. If this plan is followed, it will be possible to move loco coal in block-loads of quarter to full rakes, and thus to reduce marshalling at colliery base stations and junctions en route and obtain speedier movements of coal.

236. Simultaneously another short-term programme should be undertaken to remove the bottle-necks which are now compelling coal transport over longer alternative routes, and to expand those junction yards which are now causing heavy wagon detentions due to difficulties of marshalling and train formations or because of lack of loading or unloading facilities. A short-term programme of this nature will not involve heavy additional expenditure and should be immediately adopted. An appreciable reduction in turn-round period giving an increase in wagon availability of at least 5 per cent. will result from—(1) planned distribution of coal, with a steady flow of coal traffic in block-loads (quarter to full rakes) along definite routes, (2) shorter loads, (3) improved facilities for loading and unloading at destination stations, (4) closer supervision over train movements, and (5) pilot-wise allocations of coal orders giving a general reduction in marshalling operations, both at base stations and junction yards en route.

Bottlenecks

237. Appendix 19 gives a summary of the bottlenecks on Indian Railways. Items under short-term programme are listed below:—

(a) **Improvements in the Transhipment facilities—**

(i) Provision or extension of dumps

Banaras and Lucknow on the North Eastern Railway, Hotgi, Tadepalli, and Guntakal on the Southern Railway.

(ii) General improvements in the transhipment arrangements.
Manmad, Poona and Khandwa on the Central Railway.

(iii) Improvements in ferry services

Mokameh Ghat and Bhagalpur on the North-Eastern Railway.

(b) **Improvements in line capacity**

(i) Additional yard facilities

Agra East Bank, Sabarmati, Viramgam, Surendranagar and Ratlam on the Western Railway.

Katni on the Central Railway.

Bezwada and Rajahmundry on the Southern Railway.

(ii) Extension of loops and/or provision of additional crossing stations.

Katni-Bina on the Central Railway.

Kotah-Ratlam-Baroda, Jalgaon-Surat, Agra East Bank-Bandikui-Sojat Road and Sabarmati-Mehsana on the Western Railway.

Madras-Bezwada on the Southern Railway.

(iii) Doubling of track.

Bundi-Barkhera on the Central Railway.

Most of the above items are already under the consideration of the Railways concerned. The Committee, however, would like to stress the need for giving highest priority to them in view of their urgency for improving coal transport.

238. The transhipment points on all Railways constitute a serious bottleneck in the movement of coal, partly due to insufficient yard and handling facilities and partly due to shortage of wagons. A map at Appendix 19 shows the bottlenecks at transhipment points. Each transhipment point has its own difficulties which have to be dealt with in the light of local conditions. For instance, Mokameh Ghat is one of the main handicaps to the movement of coal from Bengal and Bihar coalfields to the Eastern region (metre gauge sections) of the North Eastern Railway across the Ganga River. Difficulties arise from vagaries of the Ganga River necessitating frequent shifting of the loading berth to suit the water level of the river. The importance of Mokameh Ghat lies in the reduced lead from the Coalfields to consuming points in the eastern region of the North Eastern Railway. For instance, Sonepur is now fed from Banaras dump, which constitutes a longer route, instead of from Mokameh Ghat. Facilities for transhipment at Banaras also need to be enhanced in order to reduce leads for supplies to the central and northern sections of the North Eastern Railway. For instance, Gorakhpur supplies are now directed through Charbagh which results in a longer haulage for want of sufficient transhipment capacity at Banaras.

239. One of the main bottle-necks on the Western Railway is **Agra East Bank.**—The proposals under consideration are improvements in the broad gauge yard at this junction to effect interchange at **Tundla,** and provision of extra crossing stations south of Kotah. Regarding the metre gauge sections, there are at present no proposals for improving the track capacities on the difficult sections—Agra East Bank to Bandikui, and Bandikui to Sojat. Traffic *via* Ujjain has

restrictions. A proposal for four additional crossing stations on this section is already under consideration. Indore being a major consuming area on the metre gauge section, a broad gauge link between Ujjain and Indore is also projected. The present restriction on goods traffic over Bhusaval-Surat section arises from lack of power. The traffic demands in the near future will, however, exceed the present line capacity and additional crossing stations are being planned to meet the situation. In the Saurashtra region, Sabarmati offers restriction on account of metre gauge yard limitations and insufficient line capacity over the Sabarmati-Mehsana section. Proposals for expansion of the Sabarmati yard and provision of additional crossing stations on Sabarmati-Mehsana section are also contemplated. Other proposals which require immediate attention are improvement of yard facilities at Viramgam, Surendranagar and Ratlam, and of transhipment facilities at Sawai-Madhopur.

240. Bottlenecks on the **Southern Railway** are mainly Bezwada-Madras section, Raichur and Dronachellam. The schemes under consideration are provision of 80 vehicle loops and additional crossing stations on the Madras-Bezwada line, extension of coal dumps at Hotgi, Guntakal and Tadepalli, and provision of additional facilities at the ports of Tuticorin and Cochin. It also seems necessary to provide a dump and additional yard facilities at Bangalore for moving coal to the industrial areas of Mysore.

241. Katni-Marwara junction yard on the Central Railway offers a serious bottle-neck for flow of coal from the CIC coalfields towards western India. This bottleneck needs to be removed by laying a line to connect Katni-Marwara junction yard with the main line to Itarsi. In view of the fact that the taking of coal from Pench Valley coalfields to stations *via* Itarsi-Bhopal section is now restricted, the doubling of Budni-Barkhera section should be carried out expeditiously in order to provide increased capacity for movement of Pench Valley coals along this route to Western India. For movement of Singareni coal along metre gauge on the Southern Railway, transhipment facilities are to be increased at Secunderabad. As an immediate measure attention should be given to the proper loading of wagons so that full advantage is taken of the two ton overload. This is especially necessary, as at present wagons leaving Singareni collieries are said to average three tons under the maximum permissible loading (marked carrying capacity plus 2 tons over load allowance). **If this is a general feature,** the proper loading of wagons from such collieries should increase the supplies to the South immediately by about 11,000 tons monthly without additional wagons.

Wagon Carrying Capacity

242. We feel there is scope for improving transport by utilising the "overload allowance" of 2 tons to the maximum possible extent. Statistics indicate that the average over-loading tonnage achieved in the case of coal wagons has been of the order 1·2 tons. One reason why the 2 ton allowance has not been fully utilised so far, lies in the fact that the collieries are now penalised by way of demurrage charges and reduced price on any quantities of coal found in excess of the maximum permissible load (*i.e.,* the marked carrying capacity plus 2

tons overload) in wagons taken to weighbridges. To avoid such penalties the collieries are inclined to load their wagons well below (on an average as much as ¾ ton below) the permissible maximum loading.

243. The problem is how to check fairly accurately the tonnage in a wagon without actual weighment at collieries so as to avoid penalties for excess loading. The Committee has carried out an experiment with a measuring gauge, shown in Appendix 20, figure 16, and has been able to establish that the loading obtained by the use of this gauge, when calibrated for the particular type of wagon and coal, is within plus/minus ⅓ ton compared with the loading obtained by actual weighment. If the collieries manufacture gauges and calibrate them for the different types of wagons and coals they handle, it should be possible to **increase wagon loading by about ½ ton and thereby increase carrying capacity of the available wagons by 2 to 2½ per cent.** This will involve a relaxation to permit excess loading of wagons by ⅓ ton, which is the upper limit of measuring gauge error. The cubic capacity of the wagon should also be given to the nearest 5th of a c.ft.

244. We are informed that the Carriage and Wagons Standard Committee of the Central Standards Office for Railways has recommended cancellation of the overload allowance of two tons on account of heated bearing troubles. **We understand the Central Railway are not permitting any overloading of wagons in the outgoing fields, such as Singareni and others. We feel, however, that it is essential generally to continue the 2-ton overload allowance as the transport position has not improved in the post-war period.** This is particularly important for the coal supplies to the South, including Singareni coal. The 2 ton overload allowance represents nearly 10 per cent. (2 tons as against 22 tons) of the available carrying capacity of wagons and its abolition will jeopardise the country's transport. **Technical considerations, such as incidence of wagon hot boxes, may warrant the abolition of the overload allowance, but we are of the opinion that it will be preferable to meet such considerations by special maintenance measures till the wagon availability has sufficiently improved.**

245. There have also been numerous cases of wagons loaded below the marked carrying capacity. Such cases are detected by comparing the invoice weights with the marked carrying capacities of wagons. The Northern Railway has submitted statistics in respect of the old E.P. Railway (Appendix 21a), which show that during the period April to August 1951 the underloading of coal wagons, for which the Railway claimed compensation from the collieries concerned was of the order of 770 tons, the average underloading being roughly ¾ ton per wagon. Out of a total number of 12,981 wagons received by the ex-E.P. Railway during the period in question, the number of underloaded wagons was 1,280, i.e., 10 per cent.

246. At our instance the Eastern Railway carried out a check on the actual loco coal despatches to various Indian Railways from Ondal and Kusunda base stations over a period of ten days from 1st May 1952 in order to collect representative statistics of underloaded wagons leaving collieries. The results are given in Appendix 21b. It

will be seen that out of the 1,155 wagons checked at Ondal base station, 147 (12·7 per cent.) were found to have been underloaded to the extent in all of 104·75 tons or 0·71 tons per wagon. Similarly, out of the 507 wagons checked at the Kusunda base station, 81 (15·7 per cent.) were found to have been underloaded to the extent of in all 54·5 tons, or 0·7 ton per wagon. Thus the effective loss of carrying capacity in the case of an underloaded wagon is 2½ tons in relation to the effective maximum loading (*i.e.*, marked carrying capacity plus effective overload allowance of 1·75 tons). On an average, about 3,700 wagons are loaded by all the collieries every day out of which roughly 445 wagons, *i.e.*, about 12 per cent. are underloaded. The total loss of carrying capacity, therefore, works out to 445×2½=1,112 tons or 50 wagons per day. This loss of 50 wagons capacity per day amounts to a loss of 1·3 per cent. in coal transport.

247. We are convinced that if effective steps, such as the adoption of the measuring gauge described above or a similar device, are taken to ensure that no wagons are loaded below their marked carrying capacity and the overload allowance of 2 tons is utilised to the extent of at least 1¾ tons in actual practice, it will be possible to increase the available carrying capacity for coal transport by 3 to 4 per cent.

RATIONALISATION OF ALLOCATIONS AND ALLOTMENTS

248. **Improvements suggested.**—We have made a detailed study of the existing system of allocating coal supplies and allotting wagons. We think that the transport position and consequently the supply conditions can be further improved if the existing system is modified to include the following features:—

(a) The allocations of coal orders are made on the basis of wagon availability.

(b) Supplies are linked up with specified supply sources and colliery base stations.

(c) Public supplies are programmed in advance on a quarterly or a half yearly basis.

(d) A Railway Officer of Senior Administrative rank (Director) should be housed in the office of the Coal Commissioner and should act as Liaison Transport Officer. He should make the day to day allotment of wagons in collaboration with the Coal Commissioner.

(e) A cushion of 200 wagons daily for the Bengal and Bihar coal fields and 50 wagons daily for other coalfields is provided to meet emergent demands over and above the programmed sanctions and the allotment of this number is left to the discretion of the Coal Commissioner.

We will briefly discuss the difficulties experienced at present, which warrant the introduction of these improvements.

249. **Allocations.**—Table 31 gives the present position of the Bengal and Bihar coalfields in respect of allocation of coal orders (sanctions), actual allotment of wagons (loadings) and guaranteed minimum wagon supplies for the year 1952.

Table 31

ALLOCATIONS, ALLOTMENTS AND GUARANTEED MINIMUM WAGON SUPPLY PER DAY DURING 1952

(Bengal & Bihar Coalfields)

Season	Allocations (wagons per day)	Allotments (wagons per day)		Guaranteed minimum wagon supply per day
		Range of variations from month to month	Average for the season	
January to June 1952	3,540	2,940 to 3,070	3,020	2,935
July to December 1952	3,830	3,110 to 3,440	3,310	2,935
Average for the year	3,650	2,940 to 3,440	3,160	2,935

It will be seen that during both the periods—January to June and July to December 1952,—the allocations exceeded the actual allotments and guaranteed minimum wagon supply by about 500 and 800 wagons per day, respectively. We appreciate that the allocations are made on the basis of demands sponsored by Provincial authorities and Industrial bodies, but we feel that this basis ignores transport availability which is the governing factor. On the contrary it introduces an element of uncertainty both for the consumers and producers, and gives rise to a tendency for inflating demands for coal and wagons. At present the demands for coal are not checked by the Coal Commissioner, and we have not therefore been able to collect direct evidence of inflation in demands, but an example of inflated wagon indents is given in table 32.

Table 32

WAGON INDENTS AND ALLOTMENTS ON 17th NOVEMBER 1952 IN RESPECT OF COLLIERY BASE STATION IN DHANBAD AND ADRA DIVISIONS

	Dhanbad Division	Adra Division	Total
1. Wagon indents from collieries (based on Coal Commissioner's allocations/sanctions).	3,835	2,216	6,051
2. Indents acceptable to Railway authorities subject to availability of wagons.	2,929	1,879	4,808
3. Allotments made by the Coal Commissioner on the basis of day to day Wagon availability.	1,433	875	2,308

250. It will be seen that against the total indents for 6,051 wagons on Dhanbad and Adra Divisions, the Coal Commissioner could allot only 2,308 wagons. This clearly shows that inflated indents, resulting from allocations made on the basis of demands, had to be curtailed according to wagon availability. Besides unnecessary work involved in the screening of inflated indents, the issue of excessive allocations covering undefined period does not permit of planning the supplies. **It is, therefore, essential that allocations should be more realistic and preferably brought down to within 5 to 10 per cent. over and above wagon availability. Attention of the authorities concerned is drawn to this.**

251. **Public Coal Programmes.**—It is equally desirable to aim at the introduction of public coal programmes similar to loco coal programmes. It should not be difficult to so regulate public and industrial demands as to ensure their receipt in the Coal Commissioner's office a month or so in advance, on the basis of which quarterly or half yearly programmes could be prepared and circulated to all concerned. **The issue of such programmes will furnish collieries and railways with planned targets for production and transport respectively and will stabilise supplies.**

252. **Sanctions.**—The next stage is the actual movement of coal in accordance with the sanctions issued by the Coal Commissioner. Such sanctions should be issued on the basis of wagon availability. Table 33 gives a picture of seasonal fluctuations in wagon supplies.

TABLE 33

DAILY AVERAGE WAGON SUPPLIES (LOADING) BENGAL & BIHAR COALFIELDS.

Month	1951	Average	1952	Average for the season
January	2,875	2,870	2,939	3,016
February	2,848		3,044	
March	2,941		2,997	
April	2,870		3,067	
May	2,808		3,037	
June	2,878		3,010	
July	3,164	3,170	3,108	3,311
August	3,317		3,444	
September	3,306		3,323	
October	3,183		3,390	
November	3,116		3,330	
December	2,933		3,270	
Daily Average for the year		3,020		3,160

It will be seen that from January to June, when the colliery output is high, the transport availability is low. During the second half of the year (July to December), when the colliery output is low, the transport availability is high. It is significant to note that the average daily supplies of wagons month by month do not show much variation, and the seasonal average can be accepted as a reliable figure of wagon availability in planning supplies.

253. We have also examined the daily fluctuations in wagon supplies during 1951-52 in the case of the E.I. and B.N. sections of the Eastern Railway, in the Bengal and Bihar coalfields. Appendix 22, gives charts of wagon allotments and show that generally day to day wagon supplies do not fluctuate heavily. It is only on 2 or 3 days in a month that wagon supplies are much above or below the average figures for the month. We also find that wagon availability per day, worked out on the basis of weekly periods, falls within 8 per cent. of the average figure for the month. This indicates that monthly average of daily wagon availability is a reasonably accurate basis for sanctions. It is, however, essential that sanctions should cover limited periods and that the programmes of sanctions are prepared and made available to all concerned well in advance. Such short term programme will be more realistic and admit of better co-ordination between the Railways and the Coal Commissioner's Organisation.

254. **Liaison Transport Officer.**—It is our considered view that the execution of supply programmes should be the responsibility of the specially appointed liaison officer mentioned in para. 248(d). The transport can be best arranged by him as he will be conversant with the traffic conditions on different rail routes and in junction yards, with pilot limitations and base station operations and with foreign railway restrictions and the like. The appointment of a Senior Administrative Transport Officer of the Railways is essential for the authoritative control of coal traffic in collaboration with the Coal Commissioner.

255. **Emergencies.**—Provision may be made to reserve for the emergency requirements of the Coal Commissioner margin of 200 wagons daily for the Bengal and Bihar coalfields and 50 wagons daily for other coalfields.

256. If the measures suggested above are adopted it should be possible to meet the present coal demands of the country. An encouraging feature of these measures is that they do not involve heavy additional expenditure.

LONG TERM PLAN

Future Demands

257. Long term planning is, however, necessary to eliminate shortage of wagons and power and limitations of line capacities, and also to expand and rationalise coal movements. In the course of the next ten years the annual demands for coal are expected to rise to 52 million tons, out of which 2 million tons will be required by the collieries. The zonal development of coalfields planned to meet the progressively increasing demands for coal envisages an increase in the annual despatches from Bengal and Bihar coalfields from 23·4 million tons in 1951 to 37·7 million tons in the year 1961 requiring increased annual despatches from these coalfields to the extent of 14·3 million tons. Similarly the annual despatches from the outlying fields will increase from 5·1 million tons in 1951 to 12·3 million tons in 1961, requiring increased annual despatches from these fields of 7·2 million tons.

Additional wagons and power

258. It will be necessary to provide additional wagons and power to cope with the increasing despatches from the Bengal and Bihar and outlying coalfields. Spreading the wagon procurement programme over the period of 10 years from 1951 to 1961, a yearly increment of despatches from the Bengal and Bihar coalfields, of the order of 1·43 million tons, will require 183 additional wagons per day. Similarly a yearly increment in the despatches from the outlying fields of the order of 0·72 million tons will require 92 additional wagons per day. During the ten year programme, the annual increment of loading will be 275 wagons per day. Taking 12 days as the average turn-round period for B.G. wagons despatched from Bengal and Bihar coalfields and 8 days for those despatched from outlying fields, the number of additional B.G. wagons required every year comes to 2,196 for Bengal and Bihar coalfields and 736 for the outlying fields, a total annual increment of 2,932 wagons. Assuming that 30 per cent. of the coal despatched from Bengal and Bihar coalfields and 20 per cent. of the coal despatched from the outlying fields has to be transhipped from B.G. to M.G. lines and that an average turn-round for M.G. wagons is 6 days; the number of M.G. wagons required in the case of Bengal and Bihar coalfields works out to 660 and the number required in the case of the outlying fields works out to 220, a total of 880 per year. A ten year wagon procurement programme based on the above assumption is given in table 34, page 107.

259. It will be seen that 29,320 additional B.G. wagons and 8,800 additional M.G. wagons will be required to cope with the demands of 50/52 million tons of coal per annum in the year 1961. Further, provision has to be made in respect of wagons under repairs. Assuming that the number of wagons in the Sick Lines and Workshops is 10 per cent. of the number in service, **budget provision for 3,200 additional broad gauge and 1,000 additional metre gauge wagons will be necessary in each annual programme for the next ten years.** While planning for increased wagon availability, provision must also be made for additional power required.

Bottlenecks

260. An extract from the main list given at Appendix 19 is given below to indicate the important items of bottlenecks to be covered by the long term plan:—

(a) **Improvements in the Transhipment facilities—**

General improvements in the transhipping arrangements or provision of dumps.

Bareilly on the North Eastern Railway.

Hotgi and Secunderabad on the Central Railway.

Bangalore, Arkonam, and Katpadi on the Southern Railway.

TABLE 31

YEARLY INCREASE IN THE DESPATCHES OF COAL AND THE ADDITIONAL WAGON REQUIREMENTS DURING THE PERIOD 1951-52 TO 1961-62

Year	Coal despatches (wagons per day)					Annual requirements of additional wagons			
	Bengal & Bihar Coalfields					Broad Gauge		Metre Gauge	
	E.I.R. Section	B.N.R. Section	Total for Eastern Railway	Outlying coal-fields	Grand total	Additional No. of wagons (Progressive total)	Wagons in coal traffic (Grand total)	Additional No. of wagons (Progressive total)	Wagons in coal traffic (Grand total)
1	2	3	4	5	6	7	8	9	10
1951—52 . .	2,200	900	3,100	665	3,765	..	42,520	..	12,756
1952—53 . .	2,330	953	3,283	757	4,040	2,932	45,452	880	13,636
1953—54 . .	2,460	1,006	3,466	849	4,315	5,864	48,384	1,760	14,516
1954—55 . .	2,590	1,059	3,649	941	4,590	8,796	51,316	2,640	15,396
1955—56 . .	2,720	1,112	3,832	1,033	4,865	11,728	54,248	3,520	16,276
1956—57 . .	2,850	1,165	4,015	1,125	5,140	14,660	57,180	4,400	17,156
1957—58 . .	2,980	1,218	4,198	1,217	5,415	17,592	60,112	5,280	18,036
1958—59 . .	3,110	1,271	4,381	1,309	5,690	20,524	63,044	5,160	18,916
1959—60 . .	3,240	1,324	4,564	1,401	5,965	23,456	65,976	7,040	19,796
1960—61 . .	3,370	1,377	4,747	1,493	6,240	26,388	68,908	7,920	20,676
1961—62 . .	3,500	1,430	4,930	1,585	6,515	29,320	71,840	8,800	21,556

(b) **Improvements in line capacity.**

(i) Additional yard facilities.

**Agra East Bank and Sabarmati on the Western Railway.*

Bina, Itarsi, Amla, Ajni, Dornakal, Kazipet and Wadi on the Central Railway.

**Bezwada and Rajahmundry on the Southern Railway.*

(ii) Extension of loops and/or provision of additional crossing stations if necessary.

Cheoki-Jubbulpore, Bina-Bhopal, Bhopal-Ujjain, Kazipet-Bezwada and Shahbad-Raichur on the Central Railway.

**Kotah-Ratlam-Baroda, Jalgaon-Surat and Sabarmati-Mehsana on the Western Railway.*

**Madras-Bezwada on the Southern Railway.*

Chirmiri-Anuppur-Katni on the Eastern Railway.

(iii) Conversion of M.G. to B.G. line.

Ujjain-Indore on the Western Railway.

(iv) Additional lines.

Doubling of Asansol-Adra on Eastern Railway, and Bezwada-Madras on Southern Railway.

*(Started under short term plan.)

261. The increase of 14·3 million tons in the annual despatches from the Bengal and Bihar coalfields in the course of the next ten years calls for considerable development of the rail route capacities on the Eastern Railway. Moreover, with the restriction on the production of caking coals, the increase in the output of Bengal and Bihar coalfields will be largely obtained from the Raniganj and Karanpura fields. Sufficient capacities for moving non-caking coals from these areas to upcountry will have to be developed. At present, any excess non-caking selected grade coals produced in the Raniganj fields have almost entirely to be diverted to Calcutta port for export, bunker and coastal traffic, because these coals cannot be moved upcountry due to inadequacy of line capacities between Asansol and Dhanbad for movement over the Grand Chord towards Moghalsarai and onwards, and between Asansol and Adra for movement over the B. N. Railway section of the line towards Kharagpur and Nagpur.

262. A similar condition exists in regard to the Karanpura coal-fields. Some of the most extensive coal reserves of the country lie in this field and they are non-caking coals suitable for steam raising purposes. The present transport arrangements are, however, totally inadequate. In fact certain collieries in the Karanpura field have increased the production at the request of the Coal Commissioner, but they have not been provided with necessary wagons for the disposal of increased output. Rail transport must be developed in order that non-caking coals can be drawn to replace caking coals as otherwise caking coal conservation will be frustrated.

263. Similar conditions have been observed in the case of the CIC, Pench and Chanda Valley coalfields where the railways concerned are not able to meet even the immediate demands for wagons. Colliery outputs are consequently restricted. We have already stated in para. 47, Chapter III, that the output of the CIC, Pench and Chanda Valley coalfields can be immediately increased from 3·6 to 5 million tons **but only if wagon supply for loading can be increased from 500 to 700 per day.**

264. The movement of coal from the Bengal and Bihar fields to the south of India is impeded by difficulties of transport both by rail and sea. The south can be best served by increasing the loading of the outlying fields from the present figure of 650 wagons a day to about 1,585 wagons a day in the course of the next ten years. Here again it will be necessary to remove all bottlenecks in the rail routes for supply of coal from such outlying fields to the west and south of India.

265. We have stated in Chapter III paras. 52 and 53 that new collieries are required to be opened up both in the Karanpura and outlying coalfields. But the opening of new collieries will again require adequate transport arrangements in the Korba area (yet to be fully prospected), the construction of a rail link from Champa to Korba, a distance of 24 miles. It will also be necessary to carry out modifications to the rail line layouts in the different coalfields **for reducing pilot movements within the Colliery areas and to provide additional sidings for coal loadings.** This work should precede the mining operations.

TRANSPORT PLANNING COMMITTEE

266. The proposals included in the short-term and long-term plans for improving the country's transport will constitute a continuous process and will involve essential expenditure. We have stated the problems and indicated the lines on which planning should be undertaken. It is difficult and indeed unnecessary for us to examine and work out the financial implications of these proposals. But it is clear that a Standing Transport Planning Committee representing the Ministries of Railways and of Production and the Planning Commission should be immediately set up to examine transport needs and to undertake and execute plans for rail transport development in the light of the industrial development of the country. We have noted with satisfaction that the Railways are generally in agreement with our proposals and are alive to the urgency of implementing the measures discussed above. Nevertheless, it is apparent that rail transport development has not received the attention it deserves as an essential feature of the overall economic development of the country.

267. We recommend that—

RECOMMENDATIONS

(i) A "Standing Coal Transport Planning Committee" should be set up, consisting of the representatives of the Ministries of Railways and Production and of the Planning Commission to undertake necessary planning in respect of coal transport, and to ensure that due importance is given to coal (and other goods) transport in the economic development of the country.

(ii) Wagon turn-round and carrying capacity should be improved by—

(a) Allocating coal orders colliery-wise and pilot-wise in order to form block loads. The colliery and consuming areas should be in zones and rationally linked up to afford movement of block loads along specified directions.

(b) Ensuring that wagons are fully loaded to the carrying capacity and that full use is made to the two tons overload allowance. For this purpose the measuring gauge, shown in appendix 20, or a similar device, should be adopted.

(c) Removing transport "bottlenecks" and improving line capacities as recommended in the short-term and long-term plans.

(iii) The existing practice of allocating coal orders and wagons should be modified to give effect to regional distribution of coal, as far as possible, and to incorporate the following features:—

(a) Allocation of coal orders on the basis of wagon availability.

(b) Linking of supplies with specified supply sources and colliery base stations.

(c) Advance programming of public supplies on a quarterly or half yearly basis.

(d) Provision of a "Cushion" of 200 wagons daily for the Bengal and Bihar Coalfields and 50 wagons daily for other coalfields to meet emergent demands, the allotment of this number being left to the discretion of the Coal Commissioner.

(iv) A Railway Officer of Senior Administrative rank (Director) should be immediately appointed and housed in the office of the Coal Commissioner. He should function as Liaison Transport Officer and make day to day allotment of wagons in collaboration with the Coal Commissioner.

PART IV

FUEL ECONOMY MEASURES

CHAPTER XII

ECONOMY IN CONSUMPTION AND PREVENTION OF LOSSES

FUEL EXPENDITURE.

268. In the past two or three years the total annual expenditure incurred by Indian Railways on coal has been of the order of rupee 30·5 crores. This is inclusive of operating costs, i.e., the expenditure incurred on the movement of coal from coalfields to consuming points. Although the operating costs are now debited to a separate budget head, we have treated them as a part of fuel expenditure, because they are incidental to actual fuel consumption. Table 35 gives a breakdown of the railway coal consumption, losses and expenditure.

TABLE 35

BREAKDOWN OF COAL CONSUMPTION, LOSSES AND EXPENDITURE ON RAILWAYS

Item of consumption or loss	Quantity (million tons)	Cost of coal (million rupees)		Operating costs (Transport etc. million rupees)	Total costs (million rupees)	Percentage of total expenditure
		Pithead costs	Handling charges			
1. *Coal Consumption*						
Loco purposes (steam).	8·75	140·0	8·75	105·0	253·75	83·5
Non-loco purposes	1·0	16·0	1·0	12·0	29·0	9·5
					282·75	
2. *Coal losses*						
Handling	0·35	5·6	0·35	4·2	10·15	3·2
Pilferage	0·4	6·4	0·4	4·8	11·6	3·8
					21·75	
	10·5	168·0	10·5	126·0	304·5	100·0

(Roughly 30½ crores).

269. It will be seen that the total annual expenditure of 30·5 crores is broadly divided into about 28·3 crores on fuel consumption in loco and non-loco purposes (including operating costs) and about 2·2 crores on losses arising from handling and pilferage. We will examine each of these items separately, with a view to determine the scope of reduction in the fuel bill.

LOCO COAL CONSUMPTION

CONTROLLING FACTORS.

270. The annual consumption of coal in steam locomotives is of the order of 8·8 million tons costing rupees 14·0 crores. Adding the operating costs (Rupees 10·5 crores) and handling charges (Rupees 0·88 crores), the expenditure on loco coal works out to 25·38 crores. This is 83·5 per cent. of the total fuel expenditure. The various direct and indirect factors, which effect consumption in locomotives, are as follows: —

(a) **Direct factors**

(i) Quality of coal.

(ii) Firing conditions.

(iii) Quality of water.

(iv) Mechanical condition of locomotives and other rolling stock.

(v) Condition of track and Engineering works.

(vi) Engine failures, wagon hot boxes and sick vehicles.

(vii) Locomotive design.

(viii) Fuel saving devices.

(b) **Indirect factors.**

(i) Load-speed schedules.

(ii) Locomotive service links and intensive utilisation of power.

(iii) Working of goods trains and train control.

(iv) Traffic conditions and train marshalling orders in yard working.

The direct factors relate largely to the quality of coal and water and to the operation and performance of locomotives and the indirect factors relate to the utilisation of locomotive power.

ECONOMY MEASURES

271. **Quality of Coal.**—Inspite of good mechanical condition of locomotives and good firing, poor boiler drafting results in increased consumption of coal, ranging from **5 to 10 per cent.** Our discussions with Railway Officers have brought out that it has not been possible to standardise drafting conditions, due to wide variations in the chemical and physical characteristics (particularly volatile content and caking and non-caking properties) of coal used in locomotives. For instance, low volatile caking coals require stronger draft than do high volatile non-caking coals to achieve good combustion efficiencies. If a boiler is drafted to burn low volatile caking coals, the consumption with high volatile non-caking coals is excessive due to large carry-over (spark) losses. If on the other hand a boiler is drafted to burn high volatile non-caking coals, the combustion and consumption of low volatile caking coals are unsatisfactory due to large unburnt coal (ash pan) losses. In a word it is not possible to draft a boiler for burning efficiently the two different (high volatile non-caking and low volatile caking) qualities of coal. **If the engine crews are to take intelligent interest in the operation of boiler and achieve maximum**

economy, it is essential that complete railway districts or zones should be supplied with coals of uniform chemical and physical characteristics. Requirements of different grades will of course be determined in accordance with the types of locomotives used. This has been dealt with in Chapter VII. We are of the opinion that there is scope for economy in fuel consumption to the extent of 5 to 8 per cent., if coal of good and consistent quality is supplied to a particular locomotive.

272. **Size of coal.**—The size of coal used in locomotives is equally important. The draft cannot be satisfactorily adjusted, if the percentage of "small and dust" in the coal is large; the drafting conditions suitable for burning large coal cause considerable losses if excessive small coal is present, the losses being largely in the form of cinder discharge from the locomotive chimney. Trials have been carried out on certain railways with coals containing different percentages of "small and dust". Drafting conditions were adjusted during the trials according to the percentage of "small and dust" and to the caking and non-caking characteristics of the coal used. The results are summarised as follows:—

Coal used	Consumption units	
	Non-caking coal	Caking coal
Coal with 5 % "small and dust"	100·0	100·0
Coal with 10% "small and dust"	100·8	100·3
Coal with 15 % "small and dust"	102·1	100·9
Coal with 20% "small and dust"	103·6	101·8
Coal with 25 % "small and dust"	105·6	102·8
Coal with 30% "small and dust"	108·0	104·2

273. It will be seen that caking coal, with 15 per cent. "small and dust" gives 0·9 per cent. increase in consumption over the same coal having 5 per cent. "small and dust". Similarly, the non-caking coal with 15 per cent. "small and dust" gives an increase in consumption of 2·1 per cent. over the same coal having 5 per cent. "small and dust". The corresponding figures of increased consumption in the case of caking and non-caking coals, containing 30 per cent. "small and dust", are 4·2 per cent. and 8 per cent. respectively.

274. There have been numerous complaints made by Railways that at least a quarter of their coal supplies contain over 25 to 30 per cent. of "small and dust". The resultant increased consumption entails a loss of about 2 per cent. (assuming 40 per cent. of the supplies to be caking coals and 60 per cent. non-caking coals). **If "small and dust" is reduced to about 10 per cent., there will be scope for economy in coal consumption to the extent of 1 to 1½ per cent.**

275. **Firing conditions.**—Satisfactory firing conditions are an essential requisite for efficient utilisation of coal in a locomotive. Poor firing condition can be wasteful to the extent of 5 to 10 per cent.

in spite of satisfactory boiler drafting. The important factors affecting these conditions are:—

(a) training and experience of the firemen, and

(b) quality and size of coals used.

An experienced fireman is able to adjust the fire to meet varying demands on a locomotive boiler in actual train operation and to adapt the firing technique to the type of coal used. For instance, a high volatile non-caking coal should be fired "light and often", requiring a thin firebed for best combustion conditions and this "frequent" firing also allows of an increased secondary air supply, which is needed for such coal. On the other hand, a low-volatile caking coal needs to be fired relatively heavily, requiring a somewhat thicker firebed for best combustion.

276. A proper starting fire is also important in controlling fire conditions on the run. An experienced fireman builds a bright starting fire but heavy or light to suit the running conditions and is able to retain sufficient reserve of heat in the firebox to meet fluctuations in steam demands. "Lighting up" and "banking" fires, which together consume substantial quantities of coal in shed services, also require expert handling to avoid wastage.

277. Lack of experience on the part of firemen often leads to frequent blowing of safety valves. Considerable steam is wasted in this manner. Some 20 to 40 lb. of coal per minute may be required to furnish the steam discharged through the safety valves. Poorly controlled firing conditions may thus result in the safety valves blowing once every 10 minutes, or say, for a period of 3 minutes in an hour. This will increase consumption by 60 to 90 lb. of coal per hour, which amounts to about 2 to 3 per cent. of the coal fired.

278. The percentage of experienced and trained running staff on Railways has fallen considerably due to political changes and lack of adequate training facilities. We have noticed anxiety on the part of Railway Administrations in this respect and there is unanimity of view on the immediate need for setting up adequate training centres. This is dealt with in Chapter XV.

279. The other important factor, affecting firing conditions, *viz.*, the quality and size of coal, has been dealt with in paras. 271 and 272. It is, however, necessary to mention that poor firing conditions result in excessive quantities of cinders in firebed ashes and in smokebox char. **Combustible residue in firebed of a heat value of about 10 to 12 per cent. of the coal fired is at present a common feature.** Railways are endeavouring to reclaim by hand picking at least half of this in the form of cinders (of half inch size and above) from firebed ashes and are contemplating elaborate measures for the purpose. **Satisfactory firing conditions will reduce the combustible matter lost in firebed ashes to within 5 per cent. of the heat in coal fired out of which only half of the quantity may be of ½" size or above.**

280. The accumulation of smokebox char is generally small, because a substantial quantity (over 70 per cent.) is ejected from the chimney. Unburnt cinders in the total "carry over" to the smokebox (as determined by heat balance calculations) represent about 6 to 8 per cent. of the heat in the coal fired (often 12 to 16 per cent. in the case of non-caking coals), which amounts to about 2½ to 4 per cent. in the case of actual collection in the smokebox. Large furnace proportions enable coal pieces lifted into combustion space to burn out completely before passing out of the furnace, and thus the "carry over" to the smokebox under such conditions largely consists of ashes. Research is being conducted in U.S.A. on the design of equipment to collect smokebox cinders and reinject them into the firebox for complete combustion rather than eject them from the chimney.

281. We have read with interest the report of the Sub-Committee of the Indian Railway Fuel Committee on the reclamation of combustible residue. **We are inclined to differ from their approach to the problem. We are of the view that, although reclamation and utilisation of cinders in firebed ashes and smokebox char deserve attention under present conditions, efforts should be made to minimise the combustible residue by (a) improving firing conditions e.g., by preheated secondary air, (b) revising firebox proportions and (c) application of mechanical devices for maximum recovery of heat from the combustible matter in coal.**

282. **Quality of water.**—The chemical properties of water used in locomotive boilers have an important bearing on boiler maintenance and efficiency, which naturally reflect on the utilisation of locomotive power and coal consumption. Bad water causes excessive scale formation, corrosion of boiler plates and excessive priming. **Even the best boiler feed water drawn from natural sources is not altogether free from these defects.** Generally speaking, water supplies on Indian Railways are reasonably free from excessive scale forming and corroding impurities. In certain districts, however, like the east coast on the Southern Railway, south-east line of the Central Railway and certain sections in Rajasthan water supplies are mainly drawn from wells and such water is often very impure and harmful.

283. Dynamometer car tests carried out on Indian Railways with clean (descaled) and dirty (scaled) boilers have shown that, with a clean boiler, the fuel consumption is reduced by about 3 to 6 per cent. Researches in other countries have shown that a scale of ⅛″ thickness can cause a loss in heat value of as much as 12 per cent. The use of treated water in place of bad water therefore produces a saving in coal of about 6 per cent on an average. Frequent blowing down to avoid excessive concentration of salts in the boiler causes loss of heat, resulting in increased fuel consumption to the extent of about 2 per cent.

284. Additional advantages of water softening are improved boiler maintenance, reduced steam leakages and increased engine availability. It has been experienced that mileage of an engine between washouts can be doubled or even trebled by use of treated water, thereby reducing fuel consumption and improving engine availability. **We feel that whereas adoption of water softening is an operational**

necessity in bad water districts, its extended application will result in reduced fuel consumption and better utilisation of locomotive power and should, therefore, receive more consideration.

285. **Mechanical condition of locomotives and other rolling stock.**—A locomotive in a poor mechanical condition can cause an increase in consumption of coal, on account of (a) steam leaks from the joints and air leaks in the smokebox, (b) steam leaks across piston and valve rings, (c) unsatisfactory valve gear adjustments, (d) high engine resistance and (e) damaged or "absent" brick arches. The loss of steam, due to leaks under worst conditions, can be as high as 500 to 800 lb. an hour, or 3 to 5 per cent. of the steam output. Poor boiler drafting, resulting from air leaks in the smokebox, can completely upset firing conditions and increase unburnt coal losses from 5 to 10 per cent. Poor valve gear adjustments will reduce cylinder efficiency and can increase consumption by about 2 to 4 per cent. "Slack or worn" running gear with poor adjustment of axle box wedges increases engine resistance considerably. Damaged brick arches affect furnace temperatures and turbulence of gases in the combustion space. In fact, absence of brick arch is known to cause an increase in consumption of 5 to 12 per cent. (see Appendix 23). All these defects do not simultaneously appear in a locomotive in poor mechanical condition. Accordingly fuel wastage on account of mechanical defects generally ranges from 5 to 15 per cent.

286. On Indian Railways the mechanical condition of locomotives has been generally poor during the last 10 years. This may have easily caused excessive coal consumption, probably to the extent of about·10 per cent. Bad condition of coaches and wagons results in poor riding qualities, and brake rigging adjustments are often neglected. These two defects increase the load behind the engine and again cause increased coal consumption.

287. **Condition of track and engineering works.**—Experiments carried out on Indian Railways show that acceleration from rest of trains to speeds of 45 miles per hour and above in the case of passenger services and 30 miles per hour and above in the case of goods services consumes about 150 to 250 lb. of coal. Thus, every additional acceleration results in wastage of this quantity of coal. The track and bridges must be well-maintained to minimise permanent and temporary restrictions and to avoid frequent and unnecessary "acceleration and deceleration" of trains. The track should also be regraded where necessary to minimise gradients so as to meet traffic requirements economically in respect of loads and speeds.

288. **Engine failures and wagon hot boxes (including sick wagons).**—An engine failure results in increased consumption of ½ a ton to 2 tons of coal, directly and often much more indirectly due to incidental traffic dislocations. A hot box on a wagon or a sick vehicle involves a detention and number of shunting operations, which consume about 250 to 300 lb. of coal. Estimated wastage of coal, due to engine failures and hot boxes is upto 2 per cent. of the overall consumption. With proper maintenance and strict supervision, engine mileage per engine failure and vehicle mileage per hot box or sick vehicle could be increased at least by 30 per cent., giving a corresponding reduction in the wastage of coal caused in this manner.

289. **Locomotive design.**—Improvements in design reduce the amount of coal and steam used in a locomotive. Important design improvements are:—

(a) Front end arrangements to provide efficient drafting conditions.

(b) Types and sizes of grate to produce uniform firebed conditions and thereby reduce cinder losses.

(c) Firebox proportions and use of secondary air to improve combustion particularly with high volatile non-caking coals.

(d) Boiler barrel proportions to reduce resistance to flow of air through the boiler and improve heat absorption efficiency.

(e) General boiler design to admit of higher steam pressures and temperatures.

(f) Cylinder and valve gear proportions to improve steam distribution efficiency.

(g) Steam passage proportions to reduce pressure drop.

(h) Designs of glands, joints and packings to reduce leakage losses.

(i) Designs of running gear components to ensure good riding and low engine resistance over service mileages between scheduled repairs.

290. Locomotive design is the responsibility of the Central Standards Office for Railways. The new designs of locomotives, *viz.*, WP and WG types for broad gauge, and YP and YG types for metre gauge, for which the Central Standards Office for Railways, is responsible, mark a definite improvement on the older types. The above mentioned features of the locomotives in India have been progressively improved upon, with the result that the percentage thermal efficiency to rail has increased from 4·4 in the pre-1924 BESA types to 5·1 in modernised BESA types, and from 5·2 in pre-1926 IRS locos to 6·4 in the latest IRS locomotives. We consider that by increasing boiler pressure from 210 to 240 lb. and steam temperature from 720° to 750° F and by adopting Poppet Valve Gear for steam distribution, preheated secondary air for improving combustion (particularly with high volatile non-caking coals) and complete thermal insulation of the boiler for reducing radiation losses, it will be possible to further improve the overall thermal efficiency to rail from 6·4 per cent. to 8 per cent. This improvement will result in a reduction of coal consumption in a locomotive to the extent of about 20 per cent.

291. **Fuel Saving devices.**—A fuel saving device, commonly used on steam locomotives in Europe and America, is the feed water heater which utilises exhaust steam for preheating boiler feed and in this manner recovers a part of the heat otherwise wasted in the exhaust. Different types of feed water heaters have been used on Indian Railways but they have been discarded on account of maintenance difficulties, (particularly in the case of locomotives operating under pooling system). **Dynamometer car trials carried out on Indian Railways**

with different types of feed water heating equipment have indicated that an overall fuel economy of about 4 to 9 per cent. can be achieved by feed water heating. We are in agreement with the view of the Indian Railway Fuel Committee that maintenance difficulties can be overcome if sufficient number of locomotives, fitted with one type of equipment, are based on a single shed to justify specialised maintenance. **We concur with the Indian Railway Fuel Committee that service trials should be carried out to determine the operating costs on the basis of present day prices of feed water equipment and the scope for its adoption on Indian Railways.**

292. Another fuel saving measure, now receiving attention in India and other countries, is the use of secondary air in locomotive boilers. Compared to the stationary boiler the locomotive boiler suffers from two distinct disadvantages. Firstly, due to limited furnace proportions, relatively larger quantities of combustible matter (volatiles and coal particles) tend to burn in the combustion space, and secondly the steam production fluctuates considerably on account of varying demands of traction. Both these disadvantages make a locomotive boiler extremely sensitive to firing conditions so that slight inequilibrium in the rate of combustion and air supply results in a smoky fire. This is particularly true of hand firing and of highly volatile non-caking coals. Large furnace proportions (as obtaining on new locomotives), skilful firing, and judicious use of the firehole door opening for admitting air directly over the firebed and also of the blower for maintaining continuity (or steadier conditions) of draft will improve the stability of fire conditions. But to achieve "smokeless" combustion it is necessary to make some provision for supply of air over the firebed under properly controlled conditions.

293. It is only in recent years that application of secondary air to locomotive boilers has received attention, particularly in America where a regular campaign has been organised by each railway system to eliminate smoke nuisance. An attempt has been made to estimate heat losses resulting from smoky fire (emission of heavy smoke from the locomotive chimney). Analyses of combustion gases show that the amount of carbon monoxide (partially burnt carbon) present in them is generally below 0·3 per cent. when the exhaust from chimney is clear but it increases to as much as 2·5 per cent. when the exhaust is charged with thick black smoke. At the same time there is also heat loss due to hydrogen and hydro-carbon in the smoky exhaust. Thus heat lost due to presence of unburnt gases in exhaust may range from 1 per cent. with clear exhaust to over 10 per cent. with smoky exhaust and probably averages about 4 per cent. under poor firing conditions. Besides the heat loss due to unburnt gases, there is some increase in the quantity of the firebed and smokebox cinders as a result of smoky fire and the total heat loss under such conditions can be considerable.

294. The Research section of the Central Standards Office for Railways has recently conducted a series of trials with (secondary) air admitted over the firebed through straight openings in the sides of the firebox, and has achieved (with this simple arrangement) a reduction in fuel consumption of about 2 per cent. The broad indications of these trials are that secondary air should enter the firebox in a cyclonic and/or criss-cross flow so as to set up turbulence in the

combustion space, and that the secondary air supply should be preheated. Combustion efficiency is expected to improve to the extent of 5 per cent. or more if admission of secondary air is controlled in this manner. **Research and investigation should, therefore, be continued to develop suitable devices for large scale use of secondary air on Indian locomotives.** The matter is all the more important as high volatile non-caking coals are to be used extensively in the future.

295. **Indirect factors.**—The indirect factors, **which relate to the utilisation of locomotive power, are—**

(i) load-speed schedules,

(ii) proper train control and working of goods trains,

(iii) intensive utilisation of locomotive power, and locomotive service links, and

(iv) traffic conditions affecting train marshalling orders, yard working, etc.

296. Correct assignment of locomotives to different services provides for economic loads and speeds (*i.e.*, economic ratings). We have found that heavier types of locomotives are often employed on lighter services and *vice versa*, and goods locomotives are frequently utilised to operate passenger services. This maladjustment is stated to be due to deficiency in the right types of locomotive power, but the fact remains that certain amount of power wastage is taking place and this increases fuel consumption. Even if the right types of locomotives are available, traffic conditions influence the adoption of proper service schedules. **This is particularly true for goods services where loads and timings are found to vary considerably.**

297. In train operation, locomotive power is also spent on unproductive work such as—

(i) idle engine hours in sheds arising from engines "held in readiness" for orders,

(ii) idle engine hours on line arising from faulty train control,

(iii) light engine working arising from non-availability of locomotives at stations where traffic requires them, and

(iv) excessive engine hours spent on the travel of the locomotives from sheds to trains and back.

To minimise power wastage in unproductive work, it is essential to give closer attention to the ordering of goods trains, so that the loads hauled do not vary over a wide range, and the trains run to scheduled timings.

298. **Pooling.**—The consumption in shed services in the shape of "lighting up" and "banking" fires (see Appendix 24) can be reduced by intensive utilisation of locomotive power and by carefully planned locomotive service links. This can be achieved if the locomotives are pooled rather than assigned to individual crews. There is considerable

discussion on this matter in the Report of the Indian Railway Enquiry Committee, 1947. We quote from page 89 of that Report.

"Pooling may be of two types: there is first, what we may call 'straight pooling', in which engines are confined to the same length of run as if they were 'assigned' but are 'turned round' both at the 'home' and 'out' stations, as fast as shed facilities permit and traffic requirements demand, and are in each case taken out by the crew 'next on turn'; secondly, we have the 'extended engine run' system, where an engine works one train for a long distance without going to sheds, the crew being changed at selected stations, on the way. 'Straight pooling' has the advantage that the home shed staff get their engines back very frequently and have a good chance to 'keep an eye' on any weak points: on the other hand, straight pooling does not give much improvement in engine use (utilisation) except on sections where the traffic is reasonably dense and the engine, on arrival at destination, is fairly sure to get a train to work back after a short interval. On lines with lighter traffic 'extended engine runs' are the only means of improving utilisation. The principal pooling railways, particularly the Bengal Nagpur Railway, use a combination of both systems."

"On the other hand pooling does introduce certain problems that, if they are not satisfactorily solved, may negative the advantages. Firstly, if an engine, after leaving its home shed is to travel, perhaps, over a thousand miles before returning, during which run it is driven by a number of crews, it must be turned out in first class mechanical order. This means that suitable repair facilities and staff must be provided at each pooling home shed. We shall not attempt to itemize the minimum repair and maintenance facilities necessary for successful pooling; they must vary with the number of engines shedded and to some extent, with the distance of the shed from headquarters mechanical workshops. Further, successful pooling postulates adequate inspection staff at sheds and also the observation of a proper fixed routine of examination. For the reasons we have, given above, a driver's report on a 'pooled' engine is not enough by itself; there must be a joint report by the driver and the shed inspection staff."

"Reports have already been submitted to the Board by Mr. Ramchandran, who was placed on special duty in 1947 for the purpose of making detailed recommendations as to the improvements that should be made at sheds in order to make possible intensive locomotive utilisation. * *

* * * *

"We must again stress the point that 'pooling' to be successful must follow and not precede the building up of proper shed facilities and a suitable organisation. On some railways 'pooling' is unpopular: that can usually be traced to an attempt to introduce pooling in an emergency and without preparation: in such cases the cure may be worse than the evil"

299. We concur with the above views. We have observed that the fuel savings in shed services achieved under the pooling system are very nearly offset by the fuel wastages caused by indifferent condition of the locomotive. This is the main argument advanced by railways against the adoption of pooling system This drawback of the pooling system can be overcome if shed organisations are adequately staffed to ensure timely diagnosis of defects and proper supervision of locomotive repairs with full attention to inside and outside cleanliness, of the locomotive. Attention to the cleanliness under the assigned crew system was a major factor in its success. The same attention must be given to cleanliness under the pooling system if it is to be a success. We consider that steps should be taken immediately to improve the standards of locomotive maintenance and cleanliness to permit of their greater use in extended runs.

300. As regards the effect of traffic conditions on fuel economy, it is necessary to plan in order that shunting operations on marshalling or trains and detentions of train engines in junction yards are reduced to the minimum. Planning is also necessary in respect of regular and seasonal traffic to ensure, as far as practicable, balanced and steady loads for forward and return journeys. This will not only save coal in shunting duties and in "stand-by" losses of the train engines but will also simplify transport, which will in turn reduce coal consumption for the traffic moved.

301. We find that, although there is general appreciation of the various factors relating to economic utilisation of locomotive power, no organised effort has been made by Railways to assess fuel losses arising from these factors and to control such losses from the point of view of fuel economy. Judging by the conditions obtaining on different railway systems we consider there is scope for reducing power wastages in idle engine hours, light engine working and in shunting duties and also for improving power utilisation by judicious adoption of "partial" and "complete" pooling, which will permit extended runs and eliminate wastages in idle intervals. **We are of the view that a reduction in coal consumption upto 10 per cent. should be possible if proper control is exercised on power wastages in this field.**

Scope for economy in loco coal consumption

302. In the foregoing paragraphs we have discussed the various factors which influence the performance and utilisation of locomotive power and have estimated the range of fuel loss for each factor separately. It is, however, important to note that no factor operates independently, and that the scope for overall fuel economy is much less when all the factors are considered together. Accordingly, our estimate of fuel savings that may be achieved by adopting measures to improve the quality of coal and water supplies and also the operation, maintenance and utilisation of locomotive power, are as follows:—

Controlling factor	Scope for fuel economy
1. Quality of coal and water supplies and firing conditions.	5 to 15%—average 8%
2. Maintenance of locomotive (and also other rolling stock).	5 to 10%—average 6%
3. Utilisation of power . . .	5 to 10%—average 6%
Total	$(1-0\cdot92\times0\cdot94\times0\cdot94)\times100=18\cdot7\%$

Thus a reduction in consumption of loco coal to the extent of about 19 per cent. is attainable if attention is given to the above factors in locomotive services. We have dealt with the human element in relation to the above in the Chapter on "Fuel Control Organisation".

303. Development of locomotive design and application of fuel saving devices are estimated to produce fuel savings as follows:—

Application of fuel saving devices .	4 to 9% - average 5 %
Loco design development (*i.e.*, adoption of higher pressures and temperatures, large furnace proportions, improved design of valve gear, running gear, spring control and suspension system etc.) . .	15 to 25% average 20%
TOTAL	$(1-0\cdot95\times0\cdot8)\times100=24\%$.

The economies on account of design improvements and application of fuel saving devices, however, relate to locomotive performance efficiency and mainly influence the consumption of coal in actual train movements, which is approximately 80 per cent of the total quantity of loco coal. The balance of 20 per cent is consumed in shed and incidental services. Thus, the saving of 24 per cent shown above will be about 19 per cent (*i.e.*, $24\times0\cdot8$) of the total loco coal.

NON-LOCO COAL CONSUMPTION

BREAKDOWN

304. The annual consumption of non-loco coal is of the order of 1 million tons. The quantities consumed in different non-loco purposes are:—

Non-loco purposes	Approximate quantity in million tons	Percentage of total: Range of variations	Percentage of total: Average for all Railways
Pumping stations	0·25	15 to 45 %	25%
Electric Power Houses	0·40	10 to 60%	40%
Mechanical Workshops	0·13	5 to 25%	13%
Engineering Departments . . .	0·02	1 to 3%	2%
Miscellaneous (ferry services, running repairs to locos, carriage and wagons, departmental sales, etc.)	0·20	15 to 40 %	20%
	1·00		100%

The pithead cost of non-loco coal is approximately rupees 1·6 crores, and the total expenditure, which includes transport and handling charges, works out to Rs. 2·9 crores, or 9·5 per cent of the railway fuel bill.

Economy Measures

305. **Pumping Stations.**—Replies to our questionnaire show that majority of Railways fix coal rations for pumping stations on the basis of average working hours per day. This is too rough a basis to afford a proper control over coal consumption. The correct basis would be a "consumption unit" fixing the quantity of coal required for pumping, say, 10,000 gallons of water. Such a unit should be determined by properly planned trials as each pumping station will have a separate "consumption unit", depending upon the type of boiler, the type of pumping engine equipment, the suction and delivery heads, the length of delivery pipe line etc. In the absence of reliable "consumption units", it is not possible to compare the operating costs of different types of pumping plants and make improvements both in the operation and maintenance and in the equipment of pumping plants. **Thus the control now exercised is limited to fuel accounting.**

306. Railways utilise cinders of ½″ size and above, reclaimed from firebed ashes and mixed with coal in the ratio of 1:3 to 1:1, as fuel for pumping station boilers. This does produce some saving in the coal requirements for pumping stations but, as we have already stated in para 279, efficient firing conditions should reduce cinder accumulation in firebed ashes to within 5 per cent, and this cannot be reclaimed in sufficient quantities for use as fuel. Thus the advantage which Railways now have in the use of cinders as fuel for pumping station boilers will gradually disappear with the improvement in loco firing conditions.

307. We find that many pumping stations are equipped with old types of vertical boilers having low boiler efficiencies. Most of these boilers are not fitted with the superheater, which could give a large improvement in engine efficiency, and reduce fuel consumption by about 15 per cent. Even locomotive boilers (unfit for locomotive service) have been used in pumping stations. This is clearly indicative of insufficient interest in the economic working of pumping stations. The matter was raised by the Fuel Economy Committee in 1944, and the Indian Railway Fuel Committee recommended in 1947 that boilers of pumping stations should be fitted with superheaters, and that new boilers should all be of the superheater type. If this recommendation had been fully implemented, there would have been a reduction in coal consumption (for pumping) of about 10 to 15 per cent. The reduction would be still greater in cases where the boiler is connected with the pumping engine by long length of steam piping, resulting in considerable condensation losses. If, in addition to this, rations are fixed on the basis of consumption units, a further reduction in coal consumption of at least 10 per cent. is possible. **It may be mentioned that steam pumping is wasteful even under the best conditions. We have observed that railways are gradually changing over to electric or diesel pumping where conditions permit. We consider this to be a move in the right direction.**

308. **Electric Power Houses.**—The coal consumption of steam operated Electrical Power Houses is roughly 40 per cent of the total quantity used in non-loco purposes. The annual expenditure on this

coal is approximately rupees 1·2 crores. Railways have small capacity Power Houses giving a daily output of 300—1000 Kilowatt Hours and also those of very large capacity giving a daily output of over 30,000 Kilowatt Hours. The majority of Power Houses, however, are of capacities giving daily outputs of 2000—10,000 Kilowatt Hours and over 70 per cent of the coal used for power generation is consumed in these Power Houses.

309. Compound steam engines of reciprocating type (with or without condensing equipment) have been generally used in power houses giving daily output upto about 6,000 Kilowatt Hours, in some cases as much as 10,000 Kilowatt Hours. Steam turbines have been provided in new plants, where daily output exceeds 6,000 Kilowatt Hours and also in existing plants under renewal or extension programmes. An attempt has been made *vide* Appendix 25 to compare actual performances of Railway power houses with the performances obtainable under the most favourable conditions. This comparison is presented in Table 36. Only the Eastern, Western and Central Railways have been included in this comparison as other railways have not supplied the required information.

TABLE 36

POWER HOUSE PERFORMANCES

(Daily consumption in lb/KWhr.)

Plant capacity		Consumption in lb/KWhr.			
Installed capacity in KVA or KW	Daily output in KWHr.	Eastern & Western Railways Performance	Central Railway Performance	For good performance: Reciprocating type Steam engine	For good performance: Steam Turbines
1	2	3	4	5	6
250/300 . .	2,000	9·5	...	6·1	...
450/500 . .	4,000	7·3	...	5·0	...
600/650 . .	6,000	6·3	10·3	4·2	2·2
700/750 . .	8,000	5·6	8·9	3·8	2·1
800/850 . .	10,000	5·2	7·6	3·4	2·0
2000/3000 . .	30,000	3·2	...	...	1·7
Above 3,500 . .	Above 60,000	2·0	...	...	1·5

310. It will be seen that Power Houses on Eastern and Western Railways consume nearly 1½ times as much coal per Kilowatt Hour as is required for the reciprocating steam engine plant and nearly 2 to 2½ times as much coal as is required for the steam turbine plant under good performance conditions. With the exception of Chola Power House (consumption 1·9 to 2·2 lb. per Kilowatt Hour) the performances achieved on the Central Railway are indeed poorer

than those achieved on the Eastern and Western Railways. Judging by the wide differences in actual and good performances, it is clear that considerable wastage of coal is taking place in the steam operated Power Houses of Indian Railways. Plant and machinery are old and obsolete in some cases. There are complaints about shortage of experienced personnel, poor and varying quality of coal supplies, pilferage, and deterioration of the stacked coal.

311. An interesting instance of the influence of quality of coal on cost of fuel for generation of steam (and electricity) is furnished by the figures of the Chola Power House given in Appendix 26. The Chola Power House mixes furnace oil with coal for steam generation. Normally, the proportion of oil in the fuel mixture is increased only to boost up the plant output, but with variations in the quality of coal the proportion of oil is frequently adjusted to obtain a suitable fuel for day-to-day working. It will be seen that in the period April to September 1949, when the quality (grade and size) of the coal supplied to Chola Power House was inferior, it was necessary to mix furnace oil and coal in the proportion of 1 to 6. In 1952 (July to December), when the coal supply was of comparatively better quality, a lean mixture of oil and coal in the proportion of 1:33 was found satisfactory. On the basis of rupees 30 per ton as the cost of coal and rupees 180 per ton as the cost of furnace oil, the cost of power house fuel in 1949 was approximately rupees 51 per ton, resulting in the fuel cost of annas 0·68 per KWHr. In 1952 the cost of power house fuel was approximately rupees 34½ per ton, resulting in fuel cost of annas 0·48 per KWHr. Thus, improvement in the quality of coal reduced the cost of fuel per KWHr by about 29 per cent.

312. We feel there is considerable scope for economy in this field. Close supervision on operation and maintenance should alone give a reduction in coal consumption of about 25 per cent. in these power houses (*i.e.*, a saving of rupees 30 lakhs annually). Furthermore, it is essential to investigate fuel wastages inherent in the types of plant and machinery used in Power Houses and to devise measures to eliminate such wastages. This is essential till such time as electric grid systems in various States have sufficiently developed and are in a position to supply cheaper power to railways and thereby enable them to dispense with small capacity (independent) railway thermal power stations.

313. **Mechanical Workshops and Engineering Departments.**—The consumption of coal and coke in Mechanical Workshops and Engineering Departments of Railways averages 15 per cent. of the total consumption in non-loco purposes. The annual expenditure on this account is roughly rupees 40 lakhs.

314. Coal is used in workshops for shunting and trial locomotives, for stationary and mobile crane boilers, and often for loading tenders of locomotives going out of shops after periodical overhaul or other repairs. The Engineering Departments use coal for manufacture of bricks. Coke is used mainly by Workshop Smithies and Foundries. We are told that Railways estimate annual or half-yearly demands of coal and coke required for these purposes on the basis of the

actual previous consumption. No "consumption units" are fixed to serve as a guide for scrutinising consumption. We consider it essential to prescribe "consumption units". For instance, in the case of Foundries the "consumption units" should be based on the quantity of coke required to produce one ton of castings. In the case of Smithies, the "consumption unit" should give the quantity of coke required for producing one ton of forgings or for hourly ratings of individual hearths. Similarly, "consumption units" can be prescribed for shunting locomotive on the basis of shunting hours, for trial locomotives on the basis of trial mileages and number of "hours of steaming", and for crane boilers on the basis of hourly ratings. Consumption units can be prescribed even for brick manufacture. We are of the view that there should be substantial economies if the fuel consumption in these fields is subjected to proper investigation and control.

315. **Miscellaneous.**—Nearly one-fifth of the non-loco coal is consumed in miscellaneous purposes. The data furnished by Railways do not give a clear breakdown of this quantity. It appears, however, that the "Miscellaneous purposes" cover departmental sales, ferry services etc. In the absence of specified items of consumption and proper accounting, it is impossible to assess wastages and suggest economy measures.

Scope for economy in non-loco coal consumption

316. The foregoing detailed examination indicates the scope for economy, and we have no hesitation in stating that under proper control the consumption in non-loco purposes can be reduced by at least 20 per cent. **This will give an annual saving of roughly rupees 60 lakhs.**

PILFERAGE LOSSES

Assessment

317. Pilferage of coal is primarily connected with a human factor, which is influenced by economic conditions, standards of education, and opportunities for such malpractice. Improvement of economic conditions and standards of education is a long-term proposition **Accordingly, immediate measures for controlling these losses should be confined to the provision of such safeguards as will minimise opportunities for pilferage.**

318. Pilferage losses differ with each railway but there is a general impression that they are not small. Railways, however, are unable to assess them on account of lack of weighment facilities in sheds, poor stacking conditions, **unsatisfactory fuel accounting**, and unreliability of trip rations caused by wide variations in coal supplies. We have endeavoured to assess pilferage losses in two parts, *viz.*, pilferage in transit and pilferage in sheds.

Pilferage in transit

319. Pilferage in transit takes place (i) by removal by miscreants of coal from coal wagons on trains stopped outside signals in rural and suburban areas, (ii) by removal of coal from wagons detained in yards for shunting and in sick lines (or at wayside stations) for

repairs, and (iii) by thefts and illicit disposals at transhipment points. Surprise weighment checks carried out by the Committee have indicated that the losses range from nil to 3 per cent, Uttar Pradesh and Bengal being the worst affected areas. **In our estimate, the total loss of coal on all Railways by pilferage in transit is about 1 per cent. of the railway fuel bill, i.e., rupees thirty lakhs annually.**

320. **Preventive measures.**—Pilferage takes place mainly from open wagons and, as it is neither possible nor desirable for various reasons to replace all open wagons by covered wagons, measures should be taken to protect open wagons. Experience has shown that the train crew or the limited number of armed guards on trains cannot stop the removal of coal from wagons as the staff are generally outnumbered by the pilferers. The only alternative therefore is to develop a suitable mechanical device for protecting open wagons. The Committee has prepared a design (Appendix 27) of an expanded metal cover for this purpose. We feel that, if adopted, this device will give adequate protection to open wagons. It appears desirable to try this or a suitably modified alternative to assess its effectiveness and cost.

321. As regards pilferage in yards and sick lines (or at wayside stations) the protective device mentioned above may also prove useful. An additional safeguard would be to seal the door locks of the proposed expanded metal cover, and to introduce a system of maintaining effective checks for ensuring that seals remain intact throughout the journey (including detentions in sick lines or at wayside stations) of an open coal wagon, as is the practice in the case of covered wagons.

322. As regards transhipment points, pilferage losses are particularly high where both loco and public coals are handled. Some quantities of coal are often left over while loading one full broad gauge wagon into, say, two metre gauge wagons. Generally such quantities are not properly protected and accounted for and furnish a field for illicit disposals. **We consider it essential to segregate the transhipment of loco and public coal and to provide fenced enclosures for loco coal.**

Pilferage in sheds

323. Lack of proper accounting, unsatisfactory stacking conditions, and unreliable trip rations are the three main factors creating conditions for pilferage. The accounting of coal received at sheds is rendered inaccurate by the fact that most of the sheds have no weighment facilities and volumetric checks have proved unreliable due to uneven stacking ground and due to wide variations in the quality and the bulk density of coal supplied, the bulk densities ranging from 38 to 44 cubic feet per ton. The coal receipts shown in the shed registers are, therefore simply the weights given on the despatch advice notes or in wagon labels. Stacking conditions are unsatisfactory due to irregular supplies and the need for having separate gradewise stacks for supplies received from numerous sources. The stacking space becomes inadequate and coal is often dumped rather than stacked. These conditions do not permit of periodic and accurate verification of the quantities in stacks. We

regard proper stacking of coal as of vital importance in checking quantities of coal received and issued, and in the avoidance of pilferage. As regards trip rations, railways have found it difficult to fix reliable values due to wide variations in coal supplies.

324. It is clear that the above factors provide a wide scope for pilferage. Although it is difficult to specify the different ways in which the leakage of coal takes place, it can be broadly divided into (i) pilferage from stacks and (ii) illicit disposals from locomotive tenders. From stacks, coal is often pilfered at night time. Pilferage takes place in several ways. For instance, some persons engaged on cinder picking and ash disposal work may get mixed up with the railway shed staff and remove coal along with cinders and ashes. Members of the public may also be often involved in such acts. Coal can also be given away from the tenders by the engine crew to public in return for monetary remuneration. Instances have come to notice, where engine crew have received "cash or kind" from the public in bags attached to sticks, which are picked up in the same way as line clear tokens. In return lump coal is dropped along the track. Coal can also be sold away at fire cleaning and watering stations.

325. Although pilferage losses in sheds are believed to be heavy, railways find it difficult to assess them. At present they are not accounted for as such. They are somehow or other adjusted—some in the issue accounts and the rest against 2 per cent. permissible write-offs. We place the pilferage losses at 3 per cent of the railway fuel bill, (*i.e.*, Rs. 90 lakhs annually), ranging from 2 to 7 per cent according to local conditions.

326. **Preventive measures.**—As already stated, most of the difficulties in controlling pilferage in sheds arise out of unsatisfactory supply conditions. These difficulties will be minimised if the recommendations made in Chapter IX are implemented in due course. **We are, however, of the opinion that it is in any case essential to provide fenced enclosures for stacking areas.**

Scope for reduction in pilferage losses

327. According to our estimate, the total loss due to pilferage in transit and sheds is of the order of 4 per cent of the railway fuel bill. **We consider that, if proper control is exercised on the lines indicated above, in the course of the next five years this loss can be greatly reduced. A 50 per cent reduction would give an annual saving of 60 lakhs.**

HANDLING LOSSES

Handling operations

328. Losses occur in handling coal from the point of loading at collieries to the point of loading into locomotive tenders. These losses are caused by—

(a) uneven loading of wagons and locomotive tenders, resulting in coal tumbling off.

(b) improper handling, and

(c) deterioration of coal in stacks.

329. **Uneven loading** results in coal falling off the wagons and locomotive tenders during train movements and shunting operations. The loss of coal on this account is small and can be avoided if the coal loaded at collieries is properly levelled up before despatch. The adoption of the Measuring Gauge (Appendix 20), recommended in Chapter XI to ensure loading of wagons to full capacity, will eliminate uneven loading. It is equally important to ensure proper and even loading of locomotive tenders.

330. **Improper handling of coal** means unnecessarily rough handling, *e.g.*, dropping it from heights during loading and unloading operations. This causes breakage of coal into "small and dust" and wastage due to coal dust being carried away by wind. The loss on this account varies with the type of coal and the quantity of "small and dust" in it. For instance, in the case of coals, which are highly friable, breakage to "small and dust" can be as high as 5 per cent and in the case of hard coals the breakage may be of the order of 2 to 3 per cent. According to the performance data given in para 272 of this chapter, the 5 per cent increase in "small and dust" in the case of friable coals will increase consumption in locomotives by about 0·8 per cent., but the 2 to 3 per cent increase in "small and dust" in the case of hard coals will not affect consumption. As regards the loss of coal dust, it may be as high as 2 to 3 per cent in certain cases. This loss can, however, be largely avoided if water is sprinkled on coal during handling operations, particularly in sheds. **According to our estimate, the overall loss on account of improper handling is of the order of 1 to 2 per cent of the total supplies.** By careful handling this loss can be reduced by 50 per cent. (i.e., **a saving of about rupees 20 lakhs annually).**

331. **Deterioration in stacks.**—The loss due to deterioration of coal in stacks primarily relates to high volatile high moisture non-caking coals, the worst affected being the coals of the outlying fields. These coals on exposure have a marked tendency to crumble into powder and also to lose in heat value by natural oxidation which may in some cases load to spontaneous combustion, especially if the stacks are large and high (above 5 feet). Railways are not in a position to assess these losses. Experience has, however, shown that in the case of caking coals such losses are practically nil, but in the case of non-caking coals they range from 1 to 5 per cent. Sixty per cent of railway supplies are non-caking coals, out of which nearly half is from the outlying fields, where the coals are often liable to oxidation. **On this basis we estimate the average loss due to deterioration of coal of all kinds in stack is 1 to 2 per cent of the railway supplies.**

332. It is important to mention that in the course of the next 5 years caking coals are expected to be replaced by non-caking coals, and the percentage of non-caking coals from the outlying fields will also go up appreciably. The increasing percentage of non-caking coals in railway supplies and their tendency for deterioration in stack are indicative of an urgent need for considering storage arrangements for these coals. **We suggest that the Railway Testing and Research Centre, Lucknow, and the Fuel Research Institute, Jealgora, should collaborate in investigating the weathering qualities of non-caking coals and suggest suitable storage arrangements.**

Scope for reduction in losses due to handling

333. Estimates for total handling losses arising from the factors discussed above are of the order of 3 to 4 per cent of the Railway supplies, *i.e.*, a loss of about rupees one crore annually. The nature and magnitude of these losses are not fully appreciated by railways. **A well planned economy drive should, in our opinion, give a minimum saving of rupees 30 lakhs annually in the course of the next 5 years.**

Handling charges

334. Handling charges consist of expenditure incurred on unloading, stacking, and re-loading of coal. Unloading and stacking operations are carried out manually, but re-loading is both mechanical and manual. These operations take place at transhipment points, loco sheds and coaling stages at station platforms. Appendix 28 gives comparative costs of coal handling, worked out on the basis of data furnished by Railways.

335. It will be seen that when the work is given on contract the cost of unloading and stacking operations ranges from 2½ to 5 annas per ton of coal, varying according to the quantities handled and the extent to which work is done during other than 'day light' hours. Irregular supply of coal to loco sheds also adversely affects handling costs, as it results in idle labour during short supply periods and in higher wages for overtime work during rush periods. Under departmental handling the cost of unloading and stacking coal goes up by 50 to 80 per cent. As regards the loading of coal, the cost of manual loading varies from 6½ to 13½ annas per ton under contract labour, and 9½ to 18 annas per ton under departmental labour, depending upon the quantities handled, which range from 20 to 120 tons per gangday (8 men make a gang and two or three gang-shifts make a gangday). The cost of mechanical loading with steam operated mobile cranes varies from 4 to 10 annas per ton of coal, the quantities handled ranging from 100 to more than 200 tons per day. With electrically operated overhead bunker type equipment which has been used on Indian Railways only for coaling at station platforms, the cost of loading varies from 6 to 14 annas per ton, the quantities of coal handled ranging from 50 to more than 100 tons per day. In the case of electrically operated traverser type equipment, the cost of mechanical loading varies from 3 to 9 annas per ton, the quantities handled ranging from 150 to more than 200 tons per day.

Economy Measures

336. We find that the cost of various coal handling operations is cheaper with contract labour than that with departmental labour. The extent to which departmental labour can be substituted by contract labour is linked up with important socio-economic considerations and we are unable to make a definite recommendation on this issue. The other avenue of economy is the extension of mechanical handling, which is restricted at present to loading operations. The cost of mechanical loading with the existing equipment (purchased at pre-war price) is cheaper than manual loading—both departmental and contractual. The present day prices of mechanical handling equipment are about 200 per cent higher than the pre-war prices.

The estimated costs of mechanical handling with new equipment are, however, lower than the costs of departmental manual loading and practically at par with the costs of manual loading carried out with contract labour. Although we find it difficult to assess the economies that are likely to accrue, we are of the definite opinion that extended application of mechanical loading should receive serious consideration, particularly for loco shed loading more than **150 tons of coal per day.**

Total Estimated Economy

337. Table 37 shows at a glance the economy that can be achieved by various measures discussed above.

TABLE 37

ESTIMATE OF FUEL SAVINGS ON 100 TONS OF RAILWAY COAL SUPPLIES.

Category	Consumption in tons	Controlling factors	Scope for economy	Estimated saving in tons
Loco coal				
(a) In actual train movements. (approximately 80%)	67.0	(i) Quality of coal and water and firing conditions.	5 to 15 % average 8%	
(b) in shed and incidental services (approximately 20%)	16·5	(ii) Maintenance of locomotives and other rolling stock	5 to 10% average 6%	
		(iii) Utilisation of loco power	5 to 10 % average 6 %	
TOTAL	83.5 tons	(1-0.92×0.94×0·94)×100=18·7%		15·6
Non-loco coal				
(a) Pumping stations (25%)	2·38	Consumption units determined by regular trials	20%	1·9
(b) Electric Power Houses (40%)	3·8			
(c) Mechanical workshops and Engineering Departments (15%)	1·42			
(d) Miscellaneous (20%)	1.9			
	9.5			
Losses				
(a) Pilferage	3.8	(i) Supply conditions. (ii) Mechanical protecting devices for open wagons. (iii) Fenced enclosures.	50%	1·9
(b) Coal handling	2.1	(i) Supply conditions. (ii) Care in loading and unloading operations. (iii) Proper stacking conditions	25%	0·8
All categories	100	...	...	20·2

It will be seen that fuel consumption including losses can be reduced by at least 20 per cent of the total railway supplies by the adoption of measures that can be progressively enforced by efficient fuel control organisations in the immediate future. This will give a saving of about rupees 6 crores annually in the course of 5 years on the basis of the present fuel bill.

338. Additional economy can be achieved by improvements in locomotive design and application of fuel saving devices indicated in para. 303. These improvements, however, constitute a continuous process and the extent of resultant economies will depend upon the intensity and results of experiment and research, and the steam locomotive replacement programmes adopted. Also as the life of a locomotive is 40 years the full benefits from improved designs will take many years to mature.

339. We recommend that—

RECOMMENDATIONS

(i) More attention should be given to provide proper stacking facilities and stacking ground and to the adequate stacking of all supplies as a check on consumption and pilferage.

(ii) Immediate steps should be taken to set up machinery for giving effect to various economy measures discussed in this chapter. These measures can be broadly divided into—

(a) Control over consumption, and

(b) Power and fuel research.

The control measures should be the function of the fuel control organisations, and power and fuel research should be the concern of the Railway Testing and Research Centre. working in collaboration with the Fuel Research Institute.

CHAPTER XIII

FUEL ACCOUNTS AND STATISTICS

FUEL ACCOUNTS

REVIEW

340. It is needless to stress the importance of a simple but effective system of maintaining fuel accounts. Such a system is not only helpful in the planning and execution of fuel economy measures but also provides an index to the results of such measures. Accordingly, we issued a questionnaire and instituted enquiries regarding fuel accounts of various Railways. We find that, the position is far from satisfactory. **There are incomplete transactions, involving large amounts in respect of coal paid for but not received and** vice versa. The position has been made worse by the existing supply conditions, under which it is difficult to link up missing coal wagons with the source. The result is large write-offs. The accuracy of stock and issue accounts is also much below the standard, as it appears to be more or less a routine in locomotive sheds to cover irregularities and pilferage losses by 'second issues' and by other similar means.

341. The position with regard to 'coal paid for and not received', and 'coal received but not paid for', is shown below:—

COAL PAID FOR AND NOT RECEIVED

	As on 31-3-1951		As on 31-3-52		Increase in the year 1951-52	
	Thousand tons	Value in thousand Rupees (Pit head)	Thousand tons	Value in thousand Rupees (Pit head)	Thousand tons	Value in thousand rupees
ll Class I Railways (except ex-Assam and ex-Mysore).	4,14	61,28	5,16	76,72	1,02	15,44
Highest being Ex. E. I. R. (inclusive of the portion transferred to Northern Railway).	2,0c	29,79	2,52	37,65	52	7,86

COAL RECEIVED BUT NOT PAID FOR

	As on 31-3-51		As on 31-3-52		Increase in the year 1951-52	
	Thousand tons	Value in thousand rupees (Pit head)	Thousand tons	Value in thousand rupees (Pit head)	Thousand tons	Value in thousand rupees
All Class I Railways (except ex.Assam and ex-Mysore).	*8,03	1,19,95	9,68	1,41,56	1,65	21,61
Highest being ex-E. I. R. inclusive of the portion transferred to Northern Railway.	3,96	57,41	5,12	73,62	1,16	16,21

* *Does not include figure of MG portion of Western Railway.*

We have not been able to find out how much of the coal under the above mentioned heads is from railway collieries and how much from market collieries.

342. From the statement submitted by the Controller of Coal Accounts, Calcutta, we find that the position regarding the outstanding bills in respect of supplies made to Railways from Government collieries during the last three years is as follows:—

TABLE 38

OUTSTANDING BILLS IN RESPECT OF SUPPLIES MADE TO RAILWAYS FROM GOVERNMENT COLLIERIES

Bills for 1949-50	Rs.	14,32,010
Bills for 1950-51	,,	1,13,066
Bills for 1951-52	,,	2,38,909
	,,	17,83,985

This amount of 17·8 lakhs does not, however, represent the total outstanding bills of the State Collieries, as the pre-1949 accounts are still under review by the Controller of Coal Accounts. We cannot, therefore, state the upto date position in respect of the outstanding bills.

343. We find that, in respect of the period prior to 1947, the ex. G.I.P. Railway had to write off 35,338 tons of 'missing coal', valued at rupees 4,17,984 and 31,944 tons of coal in respect of 'unconnected wagons', valued at rupees 3,77,280. Records are not

available to show how much of this coal was from Government collieries and how much from market collieries. Much confusion is caused by the diversion of railway coal to industries and *vice versa* and there are many cases in which payment has been made by railways for the coal diverted to industries without getting reimbursement of the amounts involved. Much of the trouble seems to arise from defective labelling of coal wagons, and when labels are lost or defaced it is often difficult to verify the receipt of coal or to trace the wagon and its source. In consequence, large 'write-offs' have of necessity appeared in the fuel accounts and these write-offs have often led to mal-practices.

344. It appears to us that even the budgetting of fuel expenditure is not done on proper lines. In the Budget Demands for grants, for the Ministry of Railways, fuel appears as a separate item only in Demand No. 7, Revenue-Ordinary Working Expenses—Operation (Fuel). This item, however, covers the expenditure on coal to be consumed in traction (loco) purposes. The expenditure on coal or other fuel used for electric traction is also placed under this head. The quantity of coal written-off on account of losses in transit, short receipts, excess issues, and pilferage is included in Demand No. 7 only since 1950-51. It appears therefore that Demand No. 7 covers only about 90 per cent of the total coal consumed on Indian Railways. The remaining 10 per cent. consumed in non-loco purposes, seems to come under other Demands.

345. In Demand No. 8—on Railways—Ordinary Working Expenses—Operation (other than Staff and Fuel) under sub-item VI—Clothing and Stores, a value is shown for coal consumed in the working of pumping stations for the supply of water for loco and domestic purposes, along with a value of fuel used in the running of rail-cars. We find it difficult to state that other Budget Demands cover non-loco coal. For example, coal issued to workshops is first charged to the 'Workshop Manufacturing Suspence Account' and then 'charged off' to the various works (under other Demands), whether it is for repairs or only for items of finished stores. Under Demand No. 16—On Open Line Works Additions—Annexure A includes an item on Stores Suspense Capital, showing the net effect of the Stores transactions during the year. These transactions also include coal receipts, issues and balances, for which there is no separate statement.

346. It is therefore not possible to get a clear picture of the purchase and balance stock of coal for each year or to locate the expenditure on coal under various items. All this reduces the value of the present system of budgetting coal expenditure. Our discussions with railways and the Railway Board indicate that they appreciate the need for rectifying these defects and are taking steps to this end.

347. In view of the unsatisfactory position of railway fuel accounts we considered it necessary to get the fuel accounts of one or two railways examined by a firm of Chartered Accountants in order to obtain expert opinion on the defects in the existing fuel accounting systems and on the ways and means for removing these defects. Accordingly, Messrs. K. S. Aiyer and Co. of Bombay were appointed

by the Railway Board to examine the fuel accounts of the Western Railway. The report submitted by the Chartered Accountants is a valuable document and should be immediately examined by railway experts in order that a standard coal accounting procedure can be evolved and adopted on all the Railways.

Defects noticed

348. We have studied with interest the Chartered Accountants' report and we find that their approach to the problem has been more or less on the lines of our views in the matter. The existing system of fuel accounting suffers from the following defects: —

(i) The existing system does not provide for an automatic, prompt and independent machinery for the inflow of information regarding destination, identity, etc. of coal wagons. The accounting forms adopted are non-standard and numerous, and the routine is cumbersome, resulting in considerable delay in accounting for coal received at a large number of individual sheds.

(ii) The coal bills are paid by railways before proper verification of the receipt of supplies.

(iii) The coal accounting work is handled by numerous parties (inclusive of individual sheds). Consequently, the scope for errors is wide and their location difficult.

(iv) The coal is accounted for in terms of 'money' and not 'quantities', adding considerably to possibilities of error due to price and grade variations. As for example,

(a) Different grades of coal get mixed up at transhipment points,

(b) Wagon labels get lost or defaced, with the result that the coal in such wagons has to be evaluated without knowing the grades, and

(c) Adoption of ratio for converting quantities into prices, without taking into consideration the proportion of different grades in supplies made to individual sheds.

(v) Unidentified coal wagons are taken into railway coal stocks and the value of such coal is estimated in terms of rupees, irrespective of quality of coal. This results in mis-accounting of debits and credits and makes it difficult to work out 'write-off' quantities.

(vi) There is large variety of coal account heads with misleading nomenclature. This gives rise to errors and confusion.

Improvements suggested

349. The Chartered Accountants have suggested a system, which is claimed to be effective and comparatively simple. The main features of their recommendations are: —

(a) The fuel accounting should be centralised at the headquarters of each of the six railway systems

(b) Wagon identity cards should be introduced to serve as an 'escort' for each coal wagon. One copy of the identity card will travel with the guard from the despatching base station right up to the destination of the wagon. A duplicate copy will be posted directly from the base station to the accounting centre at headquarters.

(c) The accounting of coal should be divided into two parts—one covering the transit of coal from the collieries to distributing centres and the other from distributing centres to individual sheds. The former should be based on the quantities of coal converted into money for easy check-up with payments and the latter should be based solely on quantities of the different grades of coals sent to individual sheds from distributing centres.

350. The centralisation of fuel accounts at headquarters, coupled with the introduction of distributing centres as the main points for receiving coal should help to rationalise and facilitate coal accounting and also to reduce **incomplete transactions on account of 'coal paid for but not received' and 'coal received but not paid for'**. The wagon identity cards, supported by wagon disposal statements (containing full particulars of identity cards and other information), one copy each of which is to be posted direct and separately by the colliery base stations to the Railway headquarters, will accelerate and ensure the flow of information regarding particulars of coal wagons. The wagon identity cards, which are to be carried by the guard right up to the point of unloading, will serve as an additional independent means for checking up wagon particulars and will also help in the identification of coal transhipped from broad gauge to metre gauge wagons, as new identity cards will be issued for metre gauge wagons and connected with the relevant broad gauge wagons. Accordingly, it will be easier for the distributing centres (and also transhipment points) to check up despatches with receipts, and the existing difficulties arising out of missing or defaced wagon labels will be largely removed. The recommendations made by the Chartered Accountants to divide coal accounts into two parts falls in line with our recommendation to introduce coal distributing centres, made in Chapter IX.

351. We should like, however, to draw attention to the following views (paras 351 to 357) which have been put forward by Mr. R. A. Massey. "The centralisation of fuel accounts coupled with the introduction of distributing centres will not necessarily reduce incomplete transactions on account of 'coal paid for but not received' and 'coal received but not paid for'. Fuel accounts on all railways have not in the past been decentralised and there have been distributing centres on the Eastern Railway. These distributing centres have been largely responsible for the incomplete transactions that exist today. The question of 'coal paid for but not received' and 'coal received but not paid for' is one of linking despatches with receipts at consuming points, and, unless a proper system is introduced, distributing centres or centralisation may not help materially."

352. "Wagon identity cards are a good feature, but the procedure suggested by the Chartered Accountants in this respect may not be practicable and may involve considerable expenditure on employment of additional staff. The additional work and time involved in checking these identity cards with the wagons (after a train has been formed) will mean that guards will be long hours on duty, and any extension of their time will obviously result in the stabling of trains and dislocation in traffic working. The present practice of paying for coal on receipt of authenticated documents or despatch advices may have to continue, as Railways are their own carriers and should be able to ensure that coal wagons booked from base stations arrive at their destination. No attempt should be made to finalise coal accounts at the intermediate stage *i.e.* linking despatches from base stations with distributing centres. This system will obviously permit of mal-practice and the importance of verification by consuming points may be lost sight of, as it will become an executive responsibility and will lose administrative control. The position therefore with regard to fuel accounts reduces to the urgent need of speedy linking of wagons when they are received at the consuming points with the despatch particulars from the collieries. At present, this linking is not satisfactory on account of—

(a) delays in the submission of documents by base stations or colliery owners,

(b) inadequate or no information on the side labels (which would help the accounting procedure),

(c) wagons arriving without side labels, and

(d) diversion of wagons by the Coal Commissioner or the Railway Authorities with little or no advices to the original consignee or the new consignee."

353. "To overcome these difficulties, the original booking particulars should be received along with the wagon by the consumer, and for this purpose a 'sealed' document holder (as shown in Appendix 29), which is similar to the present 'bracket label holder' should be affixed to each wagon. These document holders should contain a spare copy of the wagon side label giving the information shown below and any other documents required by the consumer for audit verification.

PARTICULARS TO BE SHOWN ON DUPLICATE WAGON LABELS.

FRONT	BACK
1. Wagon number . . .	Particulars of transhipment.
2. Carrying capacity	
3. Loading station.	
4. Date loaded.	
5. Colliery Index No.	
6. Grade of coal.	
7. Quantity invoiced . . .	Intimation sent by wire No. ... .
8. D.A. Note or invoice No. Date	..........to.........dated...........
9. Original destination.	

Guards of trains should treat these wagons with the sealed document holder as if they were sealed covered wagons of trains as at present. The consumer on receipt of the wagon will check the seal, remove the spare label, certify that it is received, and, after entering the particulars in the stock register, forward these labels directly to the Central Accounting Office where they can be linked with the copy forwarded directly by the booking or base station. The linking could be speeded up by the use of the existing Power Samos of Hollerith machines."

354. **Transhipment of coal.**—At present there are two systems of transhipment. One, where the coal is dealt with by the Commercial Department of the Railway and the second, where it is dealt with by the Loco Department of the Railway. The system under the Commercial Department involves considerable wastage of narrow gauge wagons, as it is necessary to unload the consignment from one particular broad gauge wagon into metre gauge wagons and not mix the consignment from one broad gauge wagon with another. This results in some metre gauge wagons containing only 3 or 4 tons against a carrying capacity of 11 tons or more. Under the loco system all coal received in broad gauge wagon is taken into stock, invoices are issued and the coal is loaded into as many metre gauge wagons as is considered necessary, each wagon being fully loaded. This system will avoid the uneconomic use of metre gauge wagons."

355. "The transhipment centres will send side lables to the Central Accounts Office, who will enter them in to separate stock registers. Invoices for distribution from transhipment centres with the side labels and received by consuming points will also be sent to the Central Accounts Office and entered as despatches in this register."

356. "The transhipment centres should be treated as base stations, and linking of despatches of wagons from transhipment centres and receipts at consuming points will be done in the same manner as broad gauge wagons are dealt with."

357. "**Colliery Index Numbers.**—All collieries should be given a a registered number by the Coal Commissioner which should be displayed on the right hand top corner of all bills, forms and correspondence. This will speed up the accounts work and will avoid errors and delays that occur now on account of the difficulties in distinguishing collieries owing to the similarity of names."

Fuel Statistics.

358. From the fuel consumption and train operation statistics, as prepared at present, it is not possible to demarcate the causes of unusual fluctuations in coal consumption or operational efficiency. For instance, it is not possible to ascertain from the statistics relating to a particular year, whether the increased consumption during that year arises from—

(i) low locomotive performance, (which in turn may be due to several causes or any one of them *e.g.*, poor mechanical condition of locomotives, inexperienced engine crew, poor quality of coal, etc.),

(ii) wasteful consumption of coal in shed services, and

(iii) uneconomic utilisation of locomotive power.

359. The quantity of coal accounted for in the statistical figure of "lb per thousand gross ton miles" is determined differently by different railways. Although the Manual of Statistical Instructions, 1946 (page 9), recommends that coal consumed in "lighting up" fire shall be included in the consumption of coal for actual train operation, on some railways it is not so included. All railways, however, include in the statistical figure of "lb per thousand gross ton miles" the coal consumed on account of—

(a) "excessive engine hours" in the travel of locomotive from the shed to the train and back,

(b) idle engine hours due to the engine "held in readiness for orders" at the outgoing pit,

(c) idle engine hours due to out-of-course and/or long detentions enroute, and

(d) steaming hours of the engine during its movement in the shed from the time of arrival at the inspection pit to the time of dropping or banking fire, for repairs and other services.

360. It will be seen that even if an engine is in good mechanical condition and is operated by efficient crew, the inclusion of consumption on the above mentioned unproductive items may reduce the over-all performance figure and make an efficient engine appear as an inefficient power unit. It is clear that it will not be possible to locate the real cause of inefficiency, unless the consumption in unproductive work is separated from the consumption in actual train operation. Accordingly, there should be two statistical figures for "lb per thousand gross ton miles", one relating to the consumption in actual train operation, for given loads and timing schedules etc., and the second covering all other factors. Variations of weather conditions also affect coal consumption, but they are adjusted in trip rationing accounts. It is not necessary therefore to group this factor with the above mentioned items of unproductive work.

361. The fuel statistics will be rationalised by the introduction of a separate section, covering consumption of coal in shed services, which may be rated on the basis of total engine miles produced by locomotives in sheds. The shed fuel statistics may show separately the consumption of coal in (i) "lighting-up fire", (ii) "banking fire", (iii) steaming hours of the locomotive from the point of its arrival at the inspection pit to the point of dropping or banking fire, and (iv) idle engine hours due to "engine held in readiness for orders".

362. There is another feature of the statistical figure of "lb per thousand gross ton miles", which needs reform. At present, the services are grouped under two main categories—"passenger and proportion of mixed" and "goods and proportion of mixed". This broad division does not furnish a fair basis for comparing the performance

of different railways, nor is it possible to correctly allocate the increase in consumption to different services in each group. For instance, in terms of "lb. per thousand gross ton miles" the consumption of a particular passenger locomotive may be 220 lb when employed on suburban trains, 140 lb when employed on mail and express trains, and 170 lb when employed on slow passenger trains. The coal consumption of the same locomotive may range from 150 to 200 lb per thousand gross ton miles when employed on mixed services. From the statistical figure of "lb per thousand gross ton miles" for all services grouped as "passenger and proportion of mixed" it is therefore difficult to apportion and assign the responsibility for deterioration in the overall performance to individual services in the group, or to link it up with different causes, such as inefficient service conditions or utilisation of locomotives, unsuitability of locomotives for services, etc. The proportions of traffic handled by different services grouped under each of the two main categories vary widely on different railways and so do the local factors relating to speeds, loads, gradients. Accordingly, the statistical figures in respect of different railways, prepared under the existing system, do not afford a fair comparison.

363. This problem was considered by the Indian Railway Fuel Committee two years ago. A sub-committee of the Indian Railway Fuel Committee was appointed to make a detailed examination. We note with interest that the sub-committee recommended the rationalisation of services groups as folllows:—

(i) Mail and express,

(ii) Suburban passenger,

(iii) Other passengers,

(iv) Total passengers,

(v) Mixed trains,

(vi) Express or through goods,

(vii) Other goods.

We are in agreement with this recommendation.

364. As regards the influence of the quality of coal on locomotive performance, it would be an advantage to introduce a statistical "figure of merit", whereby it should be possible to judge the quality of coal received and assigned to different services. The most important factor affecting the quality of coal is ash. We have accordingly worked out a "figure of merit" based on the maximum ash content of each grade of coal. **The figure of merit is based on the value of "twice the percentage of ash in coal", and is taken as "100 minus $2 \times$ ash"**. This approximate basis is supported by the experimental data on the performance of locomotives, which has established that in terms of "useful heat" the value of coal is reduced in the proportion of twice the ash for modern locomotives and $2\frac{1}{2}$ times the ash for older designs. The figure of merit worked out for different grades of coal, on the above basis, are given in table 39.

TABLE 39

"FIGURE OF MERIT" FOR DIFFERENT GRADES OF COAL.

Grade of coal	Maximum ash in coal	Figures of merit
Sel. A	15	70
Sel. B	17	66
Gr. I	20	60
Gr. II	24	52
Gr. IIIA	28	44
Gr. IIIB	35	30

365. On the basis of the values given in Table 39 above and the supplies in different grades (excluding Grades IIIA & IIIB, supplies of which were practically negligible) received by railways during the period 1947-48 to 1951-52, the average figure of merit in respect of each of these years is as follows:—

Years	Overall (Figure of Merit)
1947—48	59·9
1948—49	61·0
1949—50	61·4
1950—51	61·4
1951—52	61·2

This shows that there has been a slight improvement in quality during the last three years, which may have to some extent contributed to the reduction in coal consumption shown by the statistics for the recent years published in the annual reports of the Railway Board on the working of Railways.

366. In the foregoing paragraphs we have examined a few features of the existing fuel statistics and have suggested improvements. We may add that there is an urgent need for over-hauling and enlarging the scope of the existing statistical system so that the effects of various direct and indirect factors affecting coal consumption, as discussed in Chapter XII, are adequately and clearly brought out by the statistical figures. This will facilitate the planning and execution of measures for effecting economy in fuel. There should also be uniformity in the procedure adopted by different railways in **collecting basic statistical data** in respect of quantities of coal consumed and traffic produced. Accordingly, it is necessary to standardise the train documents and statistical forms used for this purpose, **which can more appropriately be introduced at the early stages of the working of the regrouped railways.**

367. We consider that, as a ready means for appreciating the Coal accounts position on each railway, a brief extract of fuel accounts, in the form given below, should appear in Volume I, Chapter VI, of the annual report on the working of Indian Railways.

	Tons	Rupees
(1) Opening stock balance.		
(2) Coal received in the year		
(*a*) coal paid for		
(*b*) coal not paid for		
(3) Coal issued to		
(*a*) *LOCO PURPOSES*		
Mail & Express, Passenger, Suburban, Mixed, Slow Goods, Through Goods (any other items)		
(*b*) *NON-LOCO PURPOSES*		
Pumping Stations, Electric Power Houses, Workshops, Departmental, Marine Services (any other items).		
(4) Write-offs.		
(5) Closing stock balance		
(6) Outstanding bills (coal received but not paid for) .		
(7) Outstanding supplies (coal paid for but not received)		

368. Mr. R. A. Massey, a member of the Committee, has taken the trouble to extract from the Annual Administration Reports and from the Statistical Manual on Railways certain figures regarding fuel consumption and related subjects. He has also given comments and observations. Mr. Massey's note is embodied in Appendix 30 as a "Statistical Review". It exposes in many respects the limitations and inadequacy of the existing statistical procedure.

369. We recommend that early steps should be taken to—

RECOMMENDATIONS

(i) Examine the report of the Chartered Accountants in the light of our remarks with a view to evolving a simple and effective system of fuel accounts for adoption on all the Indian Railways, and

(ii) Enlarge the scope of Railway fuel statistics so that the effects of various direct and indirect factors affecting coal consumption are adequately brought out by the statistical figures.

CHAPTER XIV

DIFFERENT TYPES OF TRACTION AND POWER AND FUEL RESEARCH

TYPES OF LOCOMOTIVE POWER

370. Like many other countries, India has hitherto primarily developed steam traction, which indeed has been the "back bone" of rail transport the world over for more than a century. Steam locomotive power, however, has its limitations, and the position of steam traction has been challenged by other types of locomotive power for some decades. Briefly stated, the need for (i) ensuring economic utilisation of the country's assets in fuel and power, and (ii) providing such types of power as will meet the growing intensity of traffic, warrants a detailed study of the problem before us. The following types of locomotive power deserve consideration:—

(i) Steam Traction.

(ii) Electric Traction.

(iii) Diesel Traction, and

(iv) Gas Turbine Traction.

The characteristics of these types have been examined in detail in Appendix 31. Below we give an assessment of their relative scope.

STEAM TRACTION

371. Modern steam locomotives, such as the WP/WGs, have an overall thermal efficiency (with reference to rail) of about 6.4 per cent. By raising boiler pressures to 240 lb. per sq. in. and steam temperature to 750/770°F, and by adoption of poppet value gear, feed water heater, pre-heated secondary air, and complete boiler insulation. **the thermal efficiency can be raised to about 8 per cent.** But these improvements have yet to be tried out in India particularly in respect of reliability and maintenance under Indian conditions. Hence for another 10 years steam locomotives may be expected to return an overall thermal efficiency of about 6·4 per cent. There are, moreover, unavoidable external losses in steam traction, arising from coal handling, stacking and pilferage and the extra coal consumption in "lighting up", "banking fire". "standby" and "boiler wash-out services", which drop the overall efficiency of steam traction to 4 to 5 per cent.

372. The annual coal consumption on steam locomotive power today is about 9 million tons. To keep pace with planned industrial development of the country, **rail traffic is expected to be doubled in the course of the next 25 years.** It is likely that in 50 years the amount of traffic will be at least treble the present day figure. If steam power alone is to meet the future demands of rail transport,

the annual coal consumption will approach 20 million tons in 25 years and 30 million tons in 50 years. At the same time the industrial development of the country will have resulted in the establishment of large scale engineering, chemical and other industries requiring high grade non-caking coals and in the considerable expansion of the metallurgical industries requiring high grade cakin coals. The known reserves of high grade caking and non-cakin coals are not excessive, and **the country's need for efficient utilisation of fuel may, therefore, compel a changeover to alternative types of power.**

373. Besides the uneconomic consumption of coal in steam traction (which the future large industrial demands for coal may not permit) railway traction by steam imposes limitations on suburban traffic due to poor acceleration and deceleration, and on the main and branch line capacities due to slow movement of trains (largely as a result of heavy gradients and of time spent in fire cleaning, fuelling, watering and other boiler requirements enroute). A stage is thus reached when the traffic capacity of the existing track falls short of the industrial and commercial requirements, and, if steam traction is continued, it becomes necessary to introduce automatic signalling, to break-up limiting block sections, to extend siding capacities, and thereafter to lay out additional lines. For example, it is understood that the existing double track between Asansol and Moghalsarai (Grand Chord section) is at present worked practically to full capacity with its 23 trains a day (19 goods and 4 passenger trains). The capacity can be increased to 29 trains a day by introducing automatic signalling and breaking up limiting block sections. We have shown in Chapter III that production of coal in Bengal and Bihar coalfields will increase from 27.4 million tons to 39.5 million tons in the course of the next 10 years. This will involve the provision of 30 additional coal trains per day, out of which about 12 will move above Asansol towards Moghalsarai and 18 will move down Asansol towards Calcutta and other destinations in West Bengal. Similar increase is expected in other goods traffic on this section due to development of Damodar Valley, Sindri and allied Engineering Works and consequent industrial schemes. Traffic demands will, therefore, eventually exceed the expanded steam traffic capacity of 29 trains a day, even if heavier locomotives (Garratt type) are employed to haul bigger loads, and it will be necessary to lay out additional lines at great cost if steam traction is continued.

374. The main advantage of steam traction today is its comparatively low initial cost, as the steam locomotive is cheap and reliable, being of simple and rugged construction. In fact, for the traffic densities that now generally obtain on different sections of the railway systems in India, the operating costs of steam traction compare favourably with the operating costs of otherwise better types of traction, such as electric or diesel traction. **With increasing traffic densities, however, the economic position of steam traction becomes more and more unfavourable.**

ELECTRIC TRACTION

375. Neither the steam nor the diesel, nor the gas turbine locomotive can compete with the electric locomotive in such traction and service characteristics as acceleration, multiple unit operation (and in consequence frequent and faster services), cleanliness and comfort (absence of smoke nuisance), most of which help to increase the capacity of the track for handling greater and higher grade traffic. These characteristics encourage and induce more passenger and goods traffic, thereby making electrification more profitable and desirable.

376. The overall efficiency of electric traction is about three times that of steam traction—but this is by no means the whole picture. India possesses large quantities of comparatively low grade coal, which can be consumed **with high efficiency** in suitably designed power generation stations **but not in steam** locomotives. Electrification will, therefore, mean a gradual transfer of the railway fuel requirements from high grade coal to lower grade coal for the power stations. This will effect conservation of the high grade coal, both caking and non-caking. Also, in many places hydro-electric power can be drawn upon and the fuel resources still further conserved.

377. **Indeed, for suburban services there is practically no alternative to electric traction.** Slow moving steam trains have their limitations in serving the needs of industrially developed and congested city areas. Furthermore, suburban services suffer from very wide traffic fluctuations in the course of the day. Traffic is concentrated during 8 to 10 A.M. and 5-30 to 7-30 P.M. Traffic during the mid-day hours is very light. All these requirements can be satisfactorily met by electric traction. Electric traction, in fact, has considerably helped in the development of Greater Bombay and in providing healthier conditions of life. For example, the number of passengers carried on Bombay suburban services of the Central Railway was 15.2 millions in 1926-27 and 140.8 millions in 1950-51. The number carried on suburban services of the Western Railway was 31.5 millions in 1930-31 and 157.4 millions in 1950-51. This means an increase of about 700 per cent. in the passenger traffic. Thus, the introduction of electric traction in the Bombay suburban area has encouraged this expansion and has also enabled the two Railways to meet the new conditions.

378. Similarly, in areas where operating conditions are made difficult by heavy gradients, the advantages of electric traction in overload capacity, regenerative braking and speed control are great. Indeed traffic density and coal and electric energy costs do not play a prominent part in providing justification for electrifying the ghat sections. The more important factors relate to the expenditure on Civil Engineering Works, axle-load limitations, horse-power ratings etc. All these factors favour electrification on ghat sections.

379. Electrification involves large capital investment, which should however be judged in the context of the annual expenditure that has to be incurred on replacement and development programmes. An attempt to meet with steam traction the expanding

traffic requirements of the country will in many cases involve considerable capital expenditure on (a) improved signalling, (b) additional crossing stations to reduce limiting block sections, (c) extended loops and sidings to accommodate bigger loads, (d) increased yard and terminal facilities and (e) laying out of additional tracks. For example, it has been estimated that if a capital expenditure of rupees 14 crores (gross) is incurred on the electrification of the Howrah-Burdwan Suburban Services, it will be possible to handle double the present day traffic. On the other hand, if electrification *is not resorted to,* it will be necessary to spend rupees 7 crores (including expenditure on replacements) to increase the steam traffic capacity by about 10 per cent. If the steam traffic capacity is to be doubled, it will be necessary not only to incur much larger capital expenditure to expand adequately the existing track and terminal facilities but also to provide additional power and coaching stock. A further consideration is that electrification will release wagons, otherwise used for the transport of railway coal, **thereby reducing the capital expenditure on future wagon supply programmes.**

Diesel Traction

380. The Diesel locomotive has the highest thermal efficiency (theoretically 35 per cent.), 30 per cent. under most favourable conditions and 24 to 28 per cent. in normal working, averaging at 26 per cent. This type of power has become popular in U.S.A. where oil supply is cheap and indigenous and where coal released from steam traction has been utilised to greater advantage in industrial purposes. The modern diesel locomotive however is complicated in component design and has "tighter" wear and size tolerances. It requires higher standards of skill in maintenance, repair costs on an average being about 50 per cent. higher than those of the steam locomotive. The service availability of this type is from 25 to 50 per cent. greater than that of the steam locomotive, as diesel power is free from any wastage of time on account of watering, fire cleaning, and other boiler requirements. The traction characteristics are superior to those of the steam locomotive, giving faster schedules, cleaner services, and greater adaptability to smaller and larger capacity train units without loss of overall efficiency.

381. In this country, however, diesel power for rail transport has to be considered in the light of non-availability of indigenous oil supplies. Although three oil refineries with a total annual capacity of 3½ million tons of crude oil will be set up in the course of the next five years, it is said that the diesel oil output of the refineries will be largely utilised to meet defence and industrial requirements. There is also the possibility of curtailment or complete stoppage of oil supply to the refineries in international emergencies. However, diesel power can be adopted with advantage

(a) for general traction on such sections as suffer from acute shortage of water and are too distant from electricity supply sources (*i.e.*, from grid lines),

(b) for shunting services in marshalling yards and goods depots (particularly those situated in the vicinity of ports, Bombay, Madras and Calcutta, even if electrified), and

(c) for light rail car services, *i.e.*, where traffic density is not heavy.

Gas Turbine Locomotive

382. Several experiments with oil burning gas turbine locomotives are in progress in Switzerland, U.S.A. and U.K., and they indicate that in the next five years diesel power will find a keen competitor in the gas turbine power, for the following reasons:—

(a) The gas turbine is a rotary type of engine of much simpler design than the diesel engine and its maintenance will eventually be less expensive.

(b) The gas turbine uses crude oil costing about rupees 200 to rupees 225 per ton instead of diesel oil costing rupees 300 to 325 per ton and has an overall efficiency of about 20 per cent.*, which compares favourably with diesel operation on the basis of fuel costs.

383. Experiments have been carried out in U.S.A. on a coal dust fired gas turbine locomotive. One problem with this type of locomotive is to design a combustor and auxiliary equipment which will eliminate ash from the heated products of combustion before passing to the turbine. The U.S.A. experiments have been carried out with coals of 8 to 10 per cent. ash, and their results will not necessarily agree with those obtained from Indian coals containing about 20 per cent. ash. In the U.K., however, a coal burning external combustion gas turbine locomotive is under construction, with the combustor incorporating a surface heat-exchange unit. In this locomotive uncontaminated air becomes the working fluid. Its estimated thermal efficiency to rail is about 14 per cent. If successful, it will permit the use of Indian coals. The results of the experiments in U.K. and elsewhere are awaited with interest.

384. A difficulty with gas turbine application at the present stage lies in the probably high initial costs and lack of experience in the operation of this type of locomotive and its maintenance problems. At present the cost of the gas turbine locomotive is reported to be three times that of the steam locomotive and the interest and depreciation on the capital outlay (and higher maintenance cost in the initial stages) may render it uneconomical. With large scale production of gas turbine locomotives at a future date, capital outlay and maintenance costs may be sufficiently reduced to make it superior to the existing steam traction. There are prospects of raising the thermal efficiency of the external combustion gas turbine to over 20 per cent. by adoption of higher gas temperature and pressures. **If such a high efficiency is reached, this type of power may indeed be a keen competitor of electric traction.** We are glad to learn that the Indian Fuel Research Institute will shortly undertake research to develop combustor-*cum*-heat transfer units suitable for coal fired gas turbines.

RELATIVE ECONOMICS

385. In examining the relative economics of different types of traction, it is to be borne in mind that capital expenditure on steam, diesel,

*Research with application of higher operating pressures and temperatures shows prospects of a thermal efficiency of 30 per cent or more being attained with internal combustion gas turbine using crude or kerosine oil.

and gas turbine traction is more or less proportional to the quantity of traffic handled. In the case of electric traction, however, the capital expenditure is not only dependent on the quantity of traffic handled but it also includes the expenditure on fixed installations, *viz.*, track equipment and structures, and power generation, transmission and conversion systems. Accordingly we have compared (a) steam traction with diesel and gas turbine traction and (b) steam traction with electric traction.

386. Appendix 32a gives the operating costs of steam, diesel, and (coal and oil burning) gas turbine locomotives for different prices of coal and oil. It will be seen from figure 23 of this Appendix that with high speed diesel oil at its present price of rupees 325 per ton in the interior, diesel power operation in main line services is **cheaper than** steam operation **only if coal costs more than rupees 39 per ton.** Again figures 25, 26 and 27 in Appendix 33 show that operating costs of diesel and steam traction are equalised on (a) rail-car services where coal costs range from rupees 29 to rupees 37 per ton, depending upon the size of the rail-car unit, and (b) shunting services where the coal costs are about rupees 30 per ton.

387. With crude oil costing rupees 200 to 225 per ton, the oil burning gas turbine locomotive becomes more economical than steam locomotive only if coal costs more than rupees 34 per ton. As regards the external combustion coal burning gas turbine locomotive (which is to be preferred for Indian coals), figure 23 shows that, with coal costing rupees 30 to 60 per ton, there is an estimated saving of 15 to 30 per cent. in operating costs when compared with the steam locomotive. The internal combustion gas turbine locomotive shows a still higher saving, but it requires coal of low ash, not readily available in the country.

388. The calculations in Appendix 32b and the family of curves in figure 24 give a co-relationship for traffic density, cost of coal, and cost of electric energy on the basis of equal operating costs for electric and steam traction. Table 40, derived from figure 24, furnishes this basis for economic comparison between steam and electric tractions.

TABLE 40

ECONOMIC COMPARISION BETWEEN STEAM AND ELECTRIC TRACTION (AT 1500 VOLT D. C.)

Traffic Density (Million Trailing tons per single track mile per annum)	Cost of electric energy (annas/KWHr) giving equal operating cost for steam and electric traction with coal costing				
	Rupees 20 per ton	Rupees 30 per ton	Rupees 40 per ton	Rupees 50 per ton	Rupees 60 per ton
2 . .	...	...	...	0·2	0·55
3 . .	...	...	0·45	0·8	...
4 . .	...	0·4	0·75	...	...
5 . .	0·2	0·55	...	...	...
6 . .	0·35	0·7	...	...	...
8 . .	0·5	0·80	...	...	...
10 . .	0·6	...	...	...	...

389. It will be seen that if electric energy is available at annas 0·5 per KWHr, the minimum traffic density (trailing tons per single track mile per annum) required to justify electric traction is, 8 millions where cost of coal is rupees 20 per ton, 5 millions where cost of coal is rupees 30 per ton, and as low as 2 millions where cost of coal is rupees 60 per ton. Generally speaking, for a given rate of electric energy, high traffic density is necessary where coal costs are low and *vice versa.*

SCOPE FOR ELECTRIFICATION

Important Considerations

390. We have noticed a tendency to examine rail-transport development schemes on the conventional basis of immediate financial returns, detached from the overall picture of national requirements and without taking into consideration the ultimate economic and working advantages. This is particularly true in the case of railway electrification schemes, requiring large capital outlay. The usual method of preliminary investigation does not take into consideration the following factors, which always arise and add to the financial justification for individual schemes—

(a) the capital expenditure on normal rehabilitation and specially on the expansion programmes under steam traction, that would be necessary if electrification were not resorted to,

(b) growth of traffic and industry which railway electrification stimulates and produces in all cases, and

(c) the impetus that railway electrification can give to rural and industrial electrification.

391. It is well known that electric traction has the definite advantage of developing suburban areas and relieving congestion. **Thus, even though schemes for suburban electrification may initially indicate low yield, the rapid development of suburban traffic, which invariably follows electric traction, is accompanied by increased financial returns, thereby justifying the capital investment.**

392. On the other hand, the adoption of electric traction for main line sections is governed by considerations different from those applicable to suburban services. On main lines, traffic densities are comparatively low and the major earnings are from goods traffic. Therefore, electric traction will be justified for such main line sections as are located in or connected with highly developed industrial and agricultural areas, or in those areas which show promise of large scale industrial and agricultural developments. The case becomes all the stronger for the main lines running through heavily graded section. In other words, to justify electric traction on main lines the existing and likely rural and industrial development of the areas concerned and the track profile, which otherwise may become a limiting factor, should be given due weight.

393. Main line electrification has also to be fitted into the general pattern of national development in respect of hydro-*cum*-thermal power on electric grids. This will facilitate development of the electric grids by providing common sub-stations and transmission lines, which will improve the load factor on the grid, reduce overall capital outlay on the generating and transmission systems, and in turn lower the cost of electric energy.

394. It is also important to note that coal burning gas turbine locomotive may become a keen competitor of electric traction in the course of the next 5 to 10 years and should, therefore, receive consideration in examining the future railway electrification schemes.

ELECTRIFICATION SCHEMES

395. Keeping in view the existing and future traffic requirements of the country, the limitations of steam traction, the need for conserving high grade coals, and last but not the least the capital expenditure involved in expanding rail transport, we consider that the electrification of the sections given in Table 41 requires urgent consideration.

TABLE 41

ELECTRIFICATION SCHEMES PROPOSED FOR CONSIDERATION

Railway	Section to be electrified	Route miles
Eastern	Suburban Services—	
	(*i*) Howrah—Burdwan (chord and main line)	151
	(*ii*) Sealdah—Ranaghat	138
	Main line—	
	(*i*) Burdwan—Gaya	242
	(*ii*) Gaya—Moghalsarai	126
Central	Igatpuri—Bhusaval (extension of the present electrified section—Bombay—Igatpuri)	192
Southern	Quilon—Ernakulam	96
	Madras—Trichinopoly	358
	Madras—Bangalore	222
	Madras—Bezwada	268
Western	Virar—Ahmedabad (extension of the present electrified section—Bombay Central —Vira	271
Northern	Delhi—Ambaa	123
		2187

396. It is neither possible nor necessary for us to work out detailed financial justification for the electrification of these sections. **We have, however, been able to get estimates in respect of the electrification of Howrah-Burdwan suburban services (main line and chord) and Igatpuri-Bhusaval main line sections of the Eastern and Central Railways,** respectively, which are given in Appendix 34.

397. **Calcutta Suburban Services.**—There is an urgent need for electrification of Calcutta suburban services in order to adequately meet immediate and future traffic requirements, to provide healthier conditions of life by removing congestion, and to give impetus to industrial developments in greater Calcutta. **The need is all the greater in view of the problem which the Government of West Bengal is now facing in rehabilitating refugees from East Pakistan in the suburbs of Calcutta.** The present Calcutta suburban traffic is about 300 per cent. more than the pre-war traffic. If the experience of Bombay and Madras is a guide, a remarkable increase will follow electrification.

398. The Eastern Railway has furnished figures showing a return of 1·9 per cent. on the estimated net capital outlay of rupees 7 crores (gross rupees 14 crores) for electrifying the suburban services of Howrah-Burdwan section (chord and main line). Estimates for the electrification of the complete suburban services on the Sealdah Division are in hand and a similar return is expected for these suburban services also. A return of 1·9 per cent (in addition to 4 per cent. interest) on net capital outlay, is normally not considered to be high enough to afford financial justification. There are, however, other considerations which show that the electrification of Calcutta suburban services should be taken up without delay to avoid wasteful expenditure on the steam traction development. For example—

(a) There are at present 77 tank engines and 59 tender engines, a total of 136 engines employed on Calcutta suburban train services. About 72 per cent. of these engines are due for condemnation during the next five years and 3 per cent. in the course of further five years. If replacement of these engines is continued there will be little use for them later on under electrification. The replacement cost would be roughly 4½ lakhs per engine. Besides this, it will be necessary to add to the existing number of engines to meet increased traffic under steam traction, as the rehabilitated steam loco power can at best handle only 10 per cent. additional traffic. If increase in suburban traffic in the course of the next ten years, at a conservative estimate, results in double the existing traffic, the capital expenditure on replacements and additions (replacements 122 engines and additions 96 engines) would amount to roughly rupees 9 crores. But, in any case the track capacity and terminal facilities cannot carry such an increase.

(b) Similarly, 35 per cent. of the existing suburban stock is already over-age and is due for replacement. In the course of the next ten years another 30 per cent. will need replacement. The suburban stock also require to be nearly doubled in this period, for meeting the increased traffic requirements under steam traction and the capital expenditure will amount to several crores. Under electric traction the requirements of suburban coaches will be much less.

399. **Burdwan-Gaya-Moghalsarai Section.**—Large scale industrial and agricultural undertakings are expected to emerge from the Damodar Valley and Hirakud Power Projects. Although a reasonably accurate assessment of these developments is not possible, it can be safely stated that demands for rail-transport will be considerably increased on the Howrah-Moghalsarai main line, **particularly in view of the fact that coal production in Bengal and Bihar will increase from 27·4 million tons to 39·5 million tons in the course of the next ten years.** This main line section is already showing signs of congested traffic and expansion of rail-transport under steam traction would involve in the course of the next five years, if not immediately, large capital expenditure on laying out additional lines, expansion of junctions and terminal facilities and provision of additional locomotive power, repair equipment and maintenance facilities. Moreover, under the existing traffic conditions, electrification will release from loco coal supplies about 110 wagons a day. With an average turn round period of 8 days, this amounts to 970 wagons (880+10 per cent. for repairs) which will save a capital expenditure of about one crore on wagon supply programme. With traffic densities doubled at a future date, the number of wagons that may be saved for other traffic would be about 1940. To this may be added the saving in locomotive power. Against 970 wagons, the estimated saving in power is about 9 locomotives and against 1940 wagons it is 18 locomotives.

400. We are told that the present shed and shop capacities for line repairs and periodical overhauls of loco power are inadequate to carry any additional loads. Large capital expenditure will therefore be involved in setting up new sheds and also in increasing the present shop capacities if steam traction is continued. On the other hand, the number of locomotives required under electric traction will be practically half the number required under steam traction and the present shed and shop facilities could be adapted to electric traction with a little additional capital expenditure. **Thus early adoption of electric traction for Howrah-Moghalsarai main line Section should eliminate conditions that would involve wasteful capital expenditure on replacing and expanding existing power, additional track and terminal facilities and shop and shed capacities under steam traction.**

401. **Igatpuri-Bhusaval.**—This section is the main artery of traffic on the Central Railway. Trains come to Bhusaval from Nagpur, Allahabad and Delhi directions and are moved onwards to Igatpuri with only a small percentage of loads diverted to Dhond from Manmad. Statistics show that the traffic on this section had increased by about 50 per cent. over the period 1939 to 1951. This amounts to an average increase of about 4 per cent. per year. With the setting up of refineries and a power house in the Trombay Island and the expansion of Chola Power House, now in progress, coal loads for the Trombay and Chola Power House put together are expected to be stepped up from half a train to about 3 trains a day in the next five years. The refineries will also offer loads for up-country directions. Besides, there are other priority and non-priority loads to be considered in the future traffic demands. We are told that, at a conservative estimate, an increase of about 2 per cent. in traffic per year may be safely assumed for this section. This increase in traffic can be met with steam traction by utilising heavier type of locomotives (Garratt type),

by providing additional banking facilities on gradients and by breaking up limit block sections. But even with the adoption of these measures the line capacity will reach saturation point under steam traction by 1956. Furthermore, taking only the coal for Trombay power house into consideration, if supplies are made by sea instead of by rail, the fuel bill for this power house will be increased by about 1·39 crores a year—most wasteful expenditure, particularly as non-caking steam coal required for this power house can be made available from C.P. without a long haul. **This by itself is a justification for the introduction of electric traction on the Igatpuri-Bhusaval section.**

402. The above considerations of course establish the urgency of the case. The Central Railway has furnished figures showing a return of 4·9 per cent. on the net capital outlay of rupees 8 crores, gross rupees 13 crores, (based on the present day prices of equipment) for extending the Bombay-Igatpuri electrified line to Bhusaval. This return figure is obtained after deducting 4 per cent. interest on capital and as such, also offers an acceptable financial justification for the scheme.

403. **Southern Railway.**—Industrial development of the South has been hampered by coal shortage. On account of the outlying fields being not sufficiently developed and also because of inadequate rail facilities for moving coal from these fields, large quantities of coal are now supplied to the Southern Railway from the Bengal and Bihar coalfields by rail and sea. Hydro power resources, supported by thermal power, are being developed to meet the energy requirements of the agricultural and industrial undertakings, and with the exploitation of the South Arcot lignite in the course of the next 5 to 10 years, the economic development of the South will force the pace of the rail-transport development. Keeping in view the future requirements of the South, it is desirable that the suburban and main line electrification schemes, such as Madras-Trichinopoly on the metre-gauge and Madras-Bangalore on the broad gauge, should be undertaken at an early date.

404. As regards Madras-Bezwada section, it is the main arterial line for traffic to and from the South and, in view of the likely future industrial developments, it will be necessary to lay out additional track to increase the line capacity under steam traction. Electrification should postpone for some considerable period the necessity for incurring large capital expenditure on additional track as the line capacity under electric traction can be increased by about 70 per cent. if sidings are extended to take bigger train loads and if additional terminal and yard facilities are provided to handle them. Moreover wagons released from loco coal supplies can be utilised to a greater advantage in moving coal and other goods for the public. This electrification scheme should therefore be considered in the context of the proposal for doubling the track under steam traction.

AVAILABILITY OF ELECTRIC POWER.

405. Map at page 155 shows the country divided into 11 zones and the development of electric power in each zone over the periods 1951-55 and 1955-60. The table in the map shows estimates of electric power required for the proposed electrification schemes against the

additional power that will become available in the respective zones by 1955 and 1960. It will be seen that, zone by zone, the railway demands range from 2 to 10 per cent. (averaging 6 per cent.) of the additional power that will become available by the year 1960. Even if the Railway demands are doubled, the load on the zonal grids in respect of railway electrification schemes will range from 4 to 20 per cent. (averaging 12 per cent.) of the additional power available by 1960. This shows that railway electrification, if developed simultaneously with State grid systems, will not be handicapped for shortage of power. **It is in any case important that transmission lines of the electric grids should run along rail routes as far as practicable.**

406. There may, however, be cases where the State grids cannot supply electric power cheap enough for railway electrification. **In such cases it may be more economical to set up railway thermal power plants,** particularly where railway lines run through colliery areas, as a thermal plant located in the coalfields may produce power even cheaper than the zonal electric grid built mainly on hydro-power resources. **For instance, the Eastern Railway may find it cheaper to set up their own thermal power plant in or near the coalfields.**

SCOPE FOR DIESELISATION

Saurashtra Railway

407. The Saurashtra Section, Gondal Region, on the Western Railway fulfils the conditions warranting the adoption of diesel traction, discussed in para. 381. The Committee is of the view that this section should be brought under diesel traction as early as possible for the following reasons:—

(a) There is scarcity of water on this section, which hampers the development of steam traction,

(b) the quality of water available on this section is not suitable for use in locomotive boilers without special treatment, which involves considerable expenditure on water treatment installations,

(c) the light track of this section has axle load limitations, which restrict the development of steam traction, and

(d) this section cannot be electrified as it is far removed from electric grids. The best alternative is dieselisation.

The diesel oil requirements of this section are estimated to be about 2,500 tons a month for the existing traffic and should not exceed 5,000 tons a month during the next ten years.

Light Railcar Services

408. In this country a high percentage of railway passengers is from rural areas. They are mostly short distance travellers. Frequent railcar services are most suited for short distance travel, particularly on branch lines. Therefore, such services have great scope, which will expand with the development of agriculture and industry. **We are of the opinion that consideration should be given to the development of diesel light railcar services to meet these requirements. Light**

railcar services may consist of two to three coach units. It will be seen from Appendix 33, Figures 25 & 26 that two coach unit is more economical on diesel power than on steam power with coal costing over rupees 29 a ton. Again, a three coach unit is more economical on diesel power than a four coach unit on steam power (the most favourable condition for steam power), with coal costing over rupees 37 a ton.

Shunting Services

409. The diesel locomotive displays maximum degree of adaptability in coping with fluctuating conditions of shunting services. It eliminates 'standby' losses and, compared to a steam locomotive, it can be kept on duty for considerably longer periods. Figure 27 Appendix 33 shows that diesel operation of shunting services will be cheaper than steam operation in areas where the cost of coal is over rupees 30 per ton. Dieselisation of shunting services has the best scope in port areas, with readily available oil supplies, and in yard working of electrified sections, where it will avoid large capital expenditure on laying and maintaining an intricate network of overhead trolly lines.

POWER AND FUEL RESEARCH

Need for Research

410. We have already discussed the characteristics and economics of and the scope for different types of traction in connection with expansion of rail transport to adequately meet the growing traffic requirements of the country. We have also drawn attention to the progress made by different types of traction in other countries, and its influence on our future plans for developing rail-transport. We consider there is an urgent need for—

(a) developing types of locomotive power, which may meet the growing traffic requirements of the country with maximum efficiency,

(b) increasing the scope for utilisation of low grade coals on railway with a view to releasing higher grades for industrial purposes, and

(c) studying, analysing and making use of the developments in other countries in respect of locomotive power and fuels.

This can, however, be achieved if power and fuel research is enlarged and intensified so as to adequately cover this field. We give below a few important items of research in respect of different types of locomotive power.

Items of Research

411. **Steam Traction.**—There is a great scope for fuel economy by increasing the thermal efficiency (to rail) of modern steam locomotives (WP/WG) from the present figure of about 6·4 per cent. to

8 per cent. by raising boiler pressures and temperatures and further enlarging boiler proportions, and by the adoption of improved types of valve gear, feed water heater, preheated secondary air and complete boiler insulation etc. These features, however, need to be subjected to continuous trials and experiments in order to establish their reliability in operation and maintenance under Indian conditions. **The research in this respect must be intensified so that design improvements are embodied in locomotives with the least delay.**

412. **Electric Traction.**—The different systems of electric traction now in use are briefly described in Appendix 36. Latest developments relate to 3.000 volt D.C. traction and 50 cycle high tension A.C. traction. Both these systems are cheaper in capital cost than the 1,500 volt D.C. system which has so far been adopted for railway electrification in this country. The 3,000 volt D.C. traction which has long been successfully tried out in other countries, can be straightaway accepted for adoption in this country. As for the high tension 50 cycle A.C. traction, **which is reported to be 20 to 30 per cent. cheaper than D.C. traction,** a large scale field experiment is necessary to study the performance (and advantages and disadvantages) of this system under Indian conditions. The result of such an experiment may have far-reaching influence on the economics of electric traction and of electric supply in this country. **Delhi-Ambala Section for which power supply may become available from the East Punjab grid at a cost of say, annas 0·4 to 0·5 per kwhr, provides a suitable field for experiment with the 50 cycle high tension A.C. system.**

413. **Diesel Traction.**—Although it has a large scope in this country, the main objection to free application of diesel traction is non-availability of indigenous oil supplies. There are proposals for setting up bye-product coke ovens in the colliery areas and large quantities of creosote oil are expected to be available from the coke ovens. The calorific value of the creosote oil is nearly equal to that of crude oil and, if it can be satisfactorily refined for use in diesel locomotives diesel power can be used in the colliery areas. Moreover diesel engines can operate on gaseous fuel with somewhat reduced power rating. If suitable designs of gas producers, using coal or coke, can be developed for capacities upto 400/500 horse power, the development of diesel power for railcar and shunting services will not then be hampered by dearth of indigenous diesel oil. Research shoud be carried out to indicate possibilities of these developments.

414. **Gas Turbine Traction.**—The external combustion gas turbine locomotive, which is now being developed in the U.K., is the type of power that may have considerable scope in this country. **The Committee considers that, simultaneously with the experiment in progress in the U.K., it is essential to initiate experiments in this country for developing the design of a combustor which will be suitable for Indian coals including lignite of the South. The possibility of application of gas producer with a view to develop a suitable gas turbine locomotive should also be investigated. . .**

415. We recommend that—

RECOMMENDATIONS

(i) Electrification of the under-mentioned sections should be given consideration:—

Railway	Section to be electrified	Route Miles
Eastern	Suburban Services—	
	(i) Howrah Division	151
	(ii) Sealdah Division	138
	Main Line—	
	(i) Burdwan—Gaya	242
	(ii) Gaya—Moghal Sarai	126
Central	Igatpuri—Bhusaval (extension of the present electrified section—Bombay—Igatpuri).	192
Southern	Quilon—Ernakulam ...	96
	Madras—Trichinopoly	358
	Madras—Bangalore	222
	Madras—Bezwada	268
Western	Virar—Ahmedabad (extension of the present electrified section—Bombay Central—Virar.	271
Northern	Delhi—Ambala	123
		2,187

(ii) Steps should be taken to introduce

(a) Diesel traction on the Saurashtra Section (Gondal Region) of the Western Railway.

(b) Diesel Light Railcar services on suitable sections, and

(c) Diesel power for shunting services.

(iii) Power and fuel research should be enlarged and intensified to—

(a) Establish the reliability in operation and maintenance of design improvements in order to expedite their incorporation in future steam locomotives,

(b) Develop other types of locomotive power to meet the growing traffic requirements of the country most efficiently,

(c) develop designs of gas producers, using coal or coke, for rating upto 400/500 H.P. in order to give impetus to dieselisation of railcar and shunting services,

(d) Investigate the possibilities of using lignite in steam locomotives and in gas turbines,

(e) Develop designs of Combustor and Heat Exchanger suitable for Indian coals, to facilitate the adoption of **external combustion gas turbine locomotives, and**

(f) Determine the performance and advantages of the high tension 50 Cycle A. C. system for electric traction.

(iv) Early action should be taken to set up a "Standing Railway Power and Electrification Planning Committee", consisting of representatives of the Ministry of Railways, the Planning Commission, and the Central Water and Power Commission, for

(a) Ensuring coordination among the authorities responsible for Industrial, Power, Transport, fuel and other national developments,

(b) Initiating scrutinising and recommending the execution of railway electrification and dieselisation schemes in a specified order of priority, and

(c) Examining the possibilities of indigenous manufacture of machinery and components to meet the maintenance requirements of electric, diesel, and other types of traction.

CHAPTER XV

FUEL CONTROL ORGANISATIONS AND TRAINING CENTRES

FUEL CONTROL ORGANISATIONS

ECONOMY CAMPAIGN

416. While discussing the scope of economy in fuel consumption and losses on railways in Chapter XII, we have indicated that the adoption of various control measures can give an annual saving of about rupees 6 crores on the basis of the present fuel bill of rupees 30·5 crores. An effective and continuous economy campaign on the lines of the proposed control measures cannot, however, be organised without adequately staffed fuel control departments and without proper training of staff. **There is, therefore, an urgent need for developing central and regional fuel control organisations and training centres on sound lines.**

PRESENT POSITION

417. Attempts to organise fuel control staff of railways on sound lines were made in 1944 by the Railway Board and later by the Indian Railway Fuel Committee (Ministry of Railways) in 1948. We have studied their recommendations with interest. We find, however, that Railways have made little progress in building up their fuel control organisations to the scales laid down by the Indian Railway Fuel Committee. Our discussions have indicated that, although there is unanimity of opinion on the need for strengthening the existing fuel control organisations, some railways are not convinced of the advantage of setting up **independent fuel control departments**. There is a feeling that the existing system of providing Loco Inspectors in districts or divisions meets the requirements.

418. Loco Inspectors attached to the Divisional Headquarters tend automatically to pay more attention to avoiding engine failures and operational irregularities than to fuel control and economy. This is natural as operational features come more directly to the notice of the departmental heads, the General Managers, and the public. We have also noticed a tendency to atribute at random and perhaps without justification the blame for service failures to "poor quality of coal". This tendency will persist so long as operating and fuel control duties are combined.

419. The existing fuel control organisations suffer from another disadvantage. Although the Indian Railway Fuel Committee have recommended appointment of **senior officers** for fuel control work, we find that **junior officers** with limited experience are often appointed as fuel officers, and, even so, they are transferred within short periods (six months or less) to other than fuel duties and there is thus no continuity. It has also come to our notice that there have been inordinate delays or refusals on the part of finance authorities in giving

sanctions to fuel organisations proposed and justified by mechanical or transportation departments of Railways. All this indicates lack of appreciation of the cost of fuel and of the monetary losses which result from inadequate control over fuel consumption. There have been "drives" for fuel economy on Indian Railways for many years, but little progress has been made. From our investigations we have come to the conclusion that railway fuel organisations cannot function properly under the control of the existing departments, which of necessity are also interested in matters other than fuel.

420. We therefore consider that immediate steps should be taken to set up---

(a) independent and permanent regional fuel control organisations, with staff specialised in fuel economy work and capable of giving training to operating staff, and

(b) a fuel directorate at the Centre for exercising over-all control over the work of regional organisations by issuing economy directives and ensuring their implementation.

REGIONAL FUEL CONTROL ORGANISATIONS

421. The Committee has already dwelt upon (a) the magnitude of railway fuel bill and the scope for economy in fuel consumption, (b) the direct and indirect factors contributing to uneconomic utilisation of fuel, (c) the inadequacy of the existing fuel control organisations and economy measures and (d) the immediate need for the establishment of adequately staffed regional and central fuel control organisations. In our opinion the regrouping of numerous Railways into six railway systems has not only added to the urgency of the matter, but has also furnished additional justification. It may not have been an economic proposition to set up a comprehensive fuel control organisation on each of the railways before regrouping, but now the position is changed. The fact that each of the regrouped railway administrations will be spending roughly rupees 5 crores every year on coal, warrants an adequately staffed fuel organisation for each group to ensure the adoption of all fuel economy measures. These fuel control organisations should be **administratively independent of other railway departments** if they are to discharge their functions satisfactorily. To repeat,

(i) the magnitude of fuel expenditure on each of the six regrouped railway systems demands and justifies the creation of an independent fuel control department for each of them,

(ii) there is and there will be a tendency to subordinate fuel economy to other considerations, if the fuel control organisation is allowed to be an integral part of any of the existing railway departments,

(iii) the creation of independent regional fuel control departments can be financially justified, and

(iv) it is possible to demarcate the functions of fuel control departments from those of other railway departments, without involving duplication, lack of co-ordination, and any great administrative difficulties.

422. We have examined the recommendations of the Indian Railway Fuel Committee regarding the set up of fuel control organisation on railways. We consider that, although the organisation recommended by the said Committee would probably have been adequate before the regrouping, the scale needs to be enlarged in view of the need for **independent fuel departments.** We recommended that the staff of such an independent fuel department for each of the new 6 railway systems be as follows:—

(i) One Chief Combustion (or Fuel) Engineer (not lower than Junior Administrative Rank) at the railway headquarters.

(ii) One Combustion (or Fuel) Engineer (Senior Scale) at the railway headquarters.

(iii) One Chief Fuel Inspector (L.G.S./Junior Scale) at the railway headquarters.

(iv) One Senior Fuel Inspector (Transportation) at the railway headquarters.

(v) Senior Fuel Inspectors for districts or divisions, one for every 4 to 6 Junior Fuel Inspectors.

(vi) Junior Fuel Inspectors for districts or divisions—one for every sixty locomotives on line, approximately.

(vii) Shed Fuel Inspectors (Supervisors)—according to requirements.

(viii) Instructing Firemen—one for 60 locomotives on line.

(ix) Clerical and Class IV staff—according to local requirements.

423. The Committee is conscious of the general dearth of suitable railway officers and staff for the proposed fuel control organisations. We have weighed this aspect against the urgent need for setting up the organisations, and have come to the conclusion that it is essential to make a start by establishing for each railway a nucleus fuel organisation which should be developed into a full-fledged fuel control department in the next two or three years.

424. Duties of the fuel control staff are detailed in Appendix 37. The Fuel Inspectors will concentrate on duties relating to coal handling in sheds, fuel consumption in shed services and in locomotives on line, supply and inspection of coal, service tests for testing coals, adjustment of steam distribution and drafting conditions, trip rationing, foot plate observations in regard to firing technique and mechanical condition of locomotives and training of running staff etc.

425. With the present low standards of firing (which are largely due to accelerated promotion of junior staff and to illiteracy of many of the firemen) fuel inspectors will have a difficult task in training the personnel. We consider that instructor-firemen should train footplate staff under the direction and supervision of Junior Fuel Inspectors.

426. We have stated earlier that apart from controlling fuel consumption by improving the performance of locomotives and by raising the standards of operating staff, it is necessary to control factors which relate to economic utilisation of locomotive power. This involves liaison with the transportation/operating departments. It is for this reason that we have recommended that one Senior Fuel Inspector (Transportation) should be attached to the **fuel control department** at headquarters. His duties will be to study service schedules, operating conditions in yards and on line, train control, etc.

427. An illustration of a regional fuel control organisation is given in Appendix 38a. In this illustration, we have assumed a railway system to consist of six divisions, each division having about 240 locomotives on line and consuming about 24,000 tons of coal per month. The cost of the supervisory cadre of such an organisation works out to approximately rupees 35,000 a month. This figure does not take into account the saving that will result from the transfer of the supervisory staff (now performing fuel control duties) to the proposed fuel control department. If that saving is accounted for, the total additional expenditure will be roughly of the order of rupees 25,000 a month. On this basis the total additional cost of regional fuel control departments for the six regrouped railway systems will work out to about rupees 1,50,000 a month. Fuel checking and other clerical staff have not been included in the scheme, as adequate staff of this category are already functioning on each Railway.

Central Fuel Control Directorate

428. At present there is no fuel control organisation at the centre. We find from the proceedings of the Indian Railway Fuel Committee that the implementation of their recommendations has been slow **and that the Centre has been unable to introduce the necessary drive for expediting progress.** We consider that no fuel economy and efficiency campaign can be effective unless the Centre is in a position to give a lead, along with guidance and technical assistance in railway fuel matters, and can take steps to see that its recommendations are followed.

429. In our opinion an adequately staffed central fuel control directorate should be immediately set up in order to—

(i) study railway fuel problems in their various aspects,

(ii) co-ordinate the work of the railway fuel control departments and to give guidance and assistance,

(iii) examine proposals and take decisions in respect of the schemes utilising alternative forms of power with a view to reducing fuel costs,

(iv) carry out periodical inspection and supervision of regional fuel control organisations to ensure that the policies of the central organisation are being implemented.

(v) draw up programmes for railway fuel research,

(vi) keep abreast with modern developments resulting from fuel research in India and other countries,

(vii) draw up fuel specifications, ...

(viii) lay down standards for, and undertake the general supervision of, regional training institutions, and

(ix) co-operate with other Ministries in coal conservation policies.

430. An illustration of the central fuel control directorate is given in Appendix 38b. This organisation may be placed under the control of a Director (Railway Fuel), with one Joint Director to assist him in matters concerning supply and inspection of coal, and control over coal consumption. Two Deputy Directors and two Assistant Directors have been included to control (a) supply and inspection and (b) fuel economy. Six Senior Fuel Inspectors are considered necessary (on the basis of one for each regrouped railway system) for examining supply conditions. They will also render advice and assistance to Railway fuel control departments in difficulties which they may experience in the implementation of directives issued by the central fuel directorate from time to time and also in the conduct of locomotive trials, coal tests, etc. The cost of the central fuel directorate is estimated at rupees 30,000 a month. **Adding this to the case of fuel control departments on the six regrouped railway systems the total cost comes to rupees 1,80,000 a month or to rupees 22 lakhs a year.**

TRAINING SCHOOL

Need for Training

431. If the fuel control organisations are to function successfully, the operating staff must take an intelligent interest in the performance of their duties and understand correct firing technique and boiler working under varying conditions of operation on line. Certain standards of general education and technical training are necessary for the personnel to appreciate and follow the methods and means adopted to improve operating efficiency, and indeed to receive instruction. Many of the illiterate or poorly educated firemen and drivers do not easily adapt themselves to methods of firing suitable for different qualities of coal, and are not able to follow instructions imparted to them; nor can they make intelligible observations about the mechanical condition of the locomotive, when booking repairs, for guidance of the maintenance staff in sheds. Low standards of firing are in many cases directly attributable to (1) accelerated promotion and premature retirement of staff (resulting from political changes in 1947), (2) illiterate men recruited in the earlier years in the categories of khalasies and firemen, and (3) variations in quality of coal. Indifferent handling of the locomotive both in the building up of the fire at start, and during the firing operations under actual running conditions, is responsible for the emission of heavy smoke, frequent blowing of the safety valve, and wasteful operation of the blower, all of which entail fuel losses. Yet these features are now common occurrences.

432. We find that railways have generally depended, for their operating efficiency, upon the experience gained by engine crew during the course of their long service, the driver being largely responsible for the training of his firemen in methods of firing and footplate

duties. Certain Railways have recently introduced short-term schemes for giving intensive training to newly appointed khalasies and firemen. These schemes differ in detail from Railway to Railway and are of a provisional nature, as they are meant to tide over the present shortage of experienced staff. In respect of locomotive maintenance, however, Railways have made efforts to train artisans and chargemen by adopting regular apprenticeship courses. On the operating side no such apprenticeship courses have been introduced. **While we appreciate the efforts made by railways in training unskilled staff during recent years to fill the gap created by the partition of the country, the standards of the operating staff continue to remain low and leave much to be desired.**

433. The importance of a higher educational standard for the operating staff has, however, recently been appreciated, and some Railways have laid down "Matriculation" or equivalent as the minimum qualification for recruitment to the category of 'A' grade firemen. This is a step in the right direction. The duties and responsibilities of drivers in different grades or categories are essentially the same. The firemen are potential drivers, and the standard of education expected of them should not vary with the grade or the category of the driver. There is, therefore. no justification for continuing the practice of recruiting uneducated firemen for railways.

434. Under the present conditions, however, it will be necessary (for some time to come) to promote illiterate staff from khalasies and firemen to higher grades, and the training of such staff is urgent. To overcome the handicap of illiteracy among the present firemen and drivers, the Eastern Railway has established adult schools at major sheds. We feel that such adult schools should be introduced on all railways, and that it will be advantageous to add to the course of studies in the adult schools a primary technical course on the fundamentals of locomotive construction and operation.

435. Most of the Railways are already spending a considerable amount of money on the apprenticeship courses laid down for the artisans and chargehands required for locomotive repair shops and maintenance sheds. The minimum educational qualification for the apprenticeship course in respect of chargehands is also "Matriculation". **We are convinced that an urgent need exists for the introduction of an apprenticeship course for firemen similar to the one already drawn up for chargehands, so that combustion and fuel control are studied by apprenticeship firemen and a sound technical training in respect of the maintenance and operation of the locomotives is acquired by them before they proceed to the footplate to perform regular duties as firemen.**

Regional Training Schools

436. The Central and Eastern Railways possess full time training schools for imparting technical training to the staff of different departments. The mechanical workshop apprentices receive their training in these schools. The two railways should expand the activities of their training schools and include technical training for the operating staff as well.

437. Each of the six railway systems is expected to have roughly a minimum of 3,000 employees in the categories ranging from khalasies to firemen. With the present state of illiteracy among the operating staff, training is necessary for over 70% of these employees, while refresher courses may suffice for the rest. Future requirements against annual wastages and demands for the increase in staff are roughly of the order of 20 per cent. of the present strength. These requirements need to be covered by full apprenticeship courses. **The Central and the Eastern Railways will perhaps require funds for additional recurring expenditure (inclusive of the emoluments of the trainees) to the extent of rupees one lakh per year to cover technical training courses for the operating staff. The remaining four regional railway systems will each need to incur expenditure in setting up training schools with capital expenditure of about 4 to 5 lakhs on schools and hostel buildings and equipment, and recurring expenditure (inclusive of the emoluments of the trainees) of about rupees 3 lakhs a year.** Of this recurring expenditure the share that may be borne by the operating department for the training of their staff should also be roughly rupees one lakh per year.

438. We have considered the views expressed by different railways on the necessity of a training school for each railway system, and have found that all railways are convinced of the advantages of the training facilities which such a school will offer in maintaining a high standard of efficiency in each department. **We have not therefore to make a laboured justification for the recommendation that early steps be taken to examine the proposal of setting up a regional training school for each of the six railways.**

Central Training School

439. It is only if loco and fuel inspectors maintain a high standard of efficiency, that control can be effectively exercised on the drivers and firemen and the maintenance staff. The Indian Railway Fuel Committee has considered what should be the qualifications and experience of loco and fuel inspectors, keeping in view the nature of their duties. They have also examined the qualifications of the existing staff serving as loco and fuel inspectors on different railways. A general observation is that majority of them are men with long service as firemen and drivers but are not well equipped with knowledge of fuel matters and of locomotive construction and maintenance. This knowledge is essential to the efficient discharge of their duties. We are, therefore, in full agreement with the views expressed by the Indian Railway Fuel Committee that a Central Training School be set up at once for giving a short course of intensive training to the present loco and fuel inspectors in order that capable personnel may be made available for manning fuel control and loco inspectors' organisations.

440. The Indian Railway Fuel Committee has suggested that the Central School should be run on a joint basis, railways sharing in the expenditure for running the school. We, however, are of the opinion that such a Central Training School should be directly under the control of the Central Fuel Directorate who should bear the expenditure for running the school. The school should be located within easy

access of the Fuel Research Institute, the School of Mines, the collieries, and the Chittaranjan Locomotive Manufacturing Works so that the Inspectors under training will have simultaneously the facilities for appreciating problems bearing on the production and preparation, and physical and chemical characteristics of coal, and colliery base station operations, and for practical training in the locomotive manufacturing shops. At the same time they may deal with problems connected with the utilisation of locomotive power, traffic conditions and so forth. A suitable location for such a school would be Dhanbad or Asansol.

441. We agree with the Indian Railway Fuel Committee, in the training course it has laid down for loco and fuel inspectors. A four months course in theory and another four months course of practical training in locomotive manufacturing shops constitute the minimum period to cover the essential items of training.

442. **We consider that the proposal of Indian Railway Fuel Committee for setting up a Central Training School, which is already awaiting a decision of the Railway Board, should be examined in the light of the suggestions we have made regarding its location and controlling authority, and that a decision on the matter should be expected.**

443. It is equally essential to provide facilities at the Railway Staff College, Baroda, for giving intensive training to officers of fuel control departments in railway operation and combustion engineering.

FINANCIAL IMPLICATIONS

444. The Committee has recommended setting up of the following:—

(i) Six Regional Fuel Control Departments.

(ii) One Central Fuel Directorate.

(iii) Six Regional Training Schools for training firemen and drivers.

(iv) One Central Training School for training Loco and Fuel Inspectors.

The estimated recurring annual expenditure on these Fuel Control Organisations and training schools will be as follows:—

		Rs.
1. Six Regional Fuel Control Departments	...	Rs. 18,00,000
2. One Central Fuel Directorate	...	Rs. 3,60,000
3. Six Regional Training Schools	...	Rs. 6,00,000
4. One Central Training School	...	Rs. 1,00,000
		Rs. 28,60,000

(rounded off to rupees 29 lakhs)

445. The present railway fuel bill works out to rupees 30·5 crores of which about rupees 17 crores is the cost of coal at pitheads and rupees $13\frac{1}{2}$ crores constitute the transport and handling charges. With proper organisation of fuel consumption on railways the saving in the railway fuel bill would be about rupees 6 crores. Against this saving, the expenditure of rupees 29 lakhs a year on the Fuel Control Organisations and training schools is amply justified.

446. We recommend the immediate setting up, on the lines indicated above, of

RECOMMENDATIONS

(i) Six Regional Fuel Control Departments,

(ii) A Central Fuel Directorate,

(iii) Six Regional Training Schools, and

(iv) A Central Training School.

DARAB CURSETJI DRIVER,
Chairman.

R. A. MASSEY,
Member.

J. W. WHITAKER,
Member.

L. S. CORBETT,
Member.

A. B. GUHA,
Member.

M. V. KAMLANI,
Member-Secretary.

P. L. VERMA,
Co-opted Member
for
Alternative types of traction,
electrification, etc.

CALCUTTA,
Dated 24th February, 1953.

GIPD—L—34 RB—11-5-54—1,500

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